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NATIONAL IRRIGATION,

&c. &c.

NATIONAL IRRIGATION,

OR THE

VARIOUS METHODS OF

WATERING MEADOWS;

AFFORDING

MEANS TO INCREASE THE POPULATION, WEALTH, AND REVENUE OF THE KINGDOM,

BY AN

AGRICULTURAL, COMMERCIAL, AND GENERAL

ECONOMY IN THE USE OF WATER.

By WILLIAM TATHAM,

AUTHOR OF THE POLITICAL ECONOMY OF INLAND NAVIGATION, AN HISTORICAL ESSAY ON THE CULTURE AND COMMERCE OF TOBACCO, COMMUNICATIONS CONCERNING THE AGRICULTURE AND COMMERCE OF AMERICA, &c.

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DEDICATION.

TO SIR JOHN SINCLAIR,

BARONET OF ULBSTER, &c. FIRST AND LATE PRESIDENT OF THE BOARD OF AGRICULTURE, &c. &c.

SIR,

THE preſſures of a war, to the merits whereof I am unfortunately blind on all ſides, have compelled me to capitulate with cuſtom, which impoſes the condition of a dedication; and to this you politely aſſent, becauſe I am perſuaded that it may gratify many when they are appriſed that you

 have

have ſeen and approved the eſſential parts of my book.

I truſt poſterity will conſider this conceſſion, from both of us, an *honorable ſurrender*: they will at leaſt learn, that we have devoted our thoughts to pacific improvements in the midſt of ſtrife and tumult; and they will perhaps credit that I am neither vain enough to ſuppoſe you will derive honor from any dedication of mine, or weak enough to believe you think ſo.

The true end of this addreſs then will be to advertiſe ſociety that we mutually agree concerning the ſubſtance of the following ſheets. It is a ſolid repaſt which alone ſuits the palate of a Briton; and I leave the flummery of adulation to thoſe who think ſo faſhionable a deſert

might

might indulge the appetite of a captious critic.

I pray to God to profper your zeal in the cares of agriculture and humanity, and have the honor to be,

Sir,

Your obedient

Humble Servant,

WM. TATHAM.

INTRODUCTION.

EVERY man who has been concerned in the publication of a book is appriſed, that the printing of the beginning of the work is the laſt office of the Printer, though it is not always ſo with the Author.

The writer, however, who has time and experience on his ſide, may ſometimes on this account have a better opportunity of correcting himſelf in the caſe of an overſight; of apologizing for thoſe inadvertencies which are wont to beſet the ſtudious man; and of appriſing his readers more fully of the tendency of his deſign.

The language in which mine is communicated is a matter of ſuch little importance, ſo that it be but intelligible, that I ſhall make no apology for the defects of erudition:

erudition: it ſatisfies me that liberal minds will diſtinguiſh the kernel from the ſhell.

In deviſing a plan for the nation to profit by, I have thought it proper to review the ſcience which I have ventured to recommend an attention to; and to trace, as far as they have occurred to me, the practical examples whereby individuals may reap inſtruction and wealth. Zealous to promote theſe uſeful ends I have been leſs ſolicitous about the eclat of the means I have uſed; and there will, probably, be found inaccuracies of ſtyle and compoſition which I do not profeſs to judge of. I perceive alſo ſome little degree of overſight in my recitals, which I feel incompetent to correct according to the tide of criticiſm: I can only ſay, that I have endeavoured to give Cæſar the things which belong to him, and to render to ſociety all thoſe duties I feel impreſſed with.

In the courſe of my readings I have ſelected ſpecimens of irrigation from various countries; and I have endeavoured to arrange them in a kind of collective order, ſo that the ſeveral methods, the means and the reſults may afford ſtimulus and practical inſtruction

ſtruction from more than the reſources of theory. I cannot but lament that the ſtate of the times prohibits the expence of illuſtrating, in this firſt eſſay, all the varieties of machinery which might well apply on plates.

The ſubject of warping, though ſomewhat new and local, will be found worthy obſervation; and I flatter myſelf that this little book will prove the means of introducing it into many countries where it has never been heard of, and of ſtimulating the practice of flooding on ſuch rivers as the Miſſiſippi, where the richeſt particles of the ſoil have too long been permitted to waſte with the unheeded decreaſe of inundations, naturally favourable to agriculture.

The irrigations of the Nile, of Spain, and of France, afford many examples which deſerve the notice of the nation and of the practical farmer; while the Engliſh Counties, on the other hand, remunerate leſſons to thoſe who have taught them. None of them are without ſome peculiar point of inſtruction: Lincolnſhire affords examples for low and ſunken grounds; Glouceſter and Wiltſhire, a complete ſyſtem for level meadows in ordinary; Cheſhire, a ſingular method

thod of procraſtinating water on hilly lands; and Devonſhire combines the watering of meadows with the means of conveying its produce.

I have paid but little attention to the head of objections againſt irrigation, becauſe all which have occurred to me ſeem to be ſo futile as to need no extraordinary arguments to ſurmount them; and the reſults which are exhibited bear an unanimous teſtimony in their favour.

The irrigation of Aberdeenſhire has furniſhed a new diſcovery of no ſmall importance: it has proved to us that heath may be changed into graſs by the mere act of ſimple irrigation; and it leads to a mode of levelling which deſerves the national care. It does more than this, it introduces us to the knowledge of an author, who, in my opinion, has done more for the cauſe of humanity than the victories of Egypt; and whoſe whole life and works are replete with benevolence and productive intelligence.

In regard to machinery for the purpoſes of irrigation, it ſhould chiefly be ſuch as the ſmall farmer may command. Simplicity and cheapneſs are the points of advantage which enables him to water more land by a

few feet elevation of his fluid; and the community will partake the benefit of this medium of accumulated ſtores. It behoves the public, however, to ſeek more powerful means to ſupport a general ſyſtem; and it ſhould be remembered that public penuriouſneſs ends frequently in private fleecing. It is otherwiſe with the individual for whoſe uſe I have recited machines and methods.

The incloſure of waſte lands, and the culture of timber, appear to me to be among the firſt conſiderations of Britiſh improvement; and I ſubmit to the reader the manner in which I have connected them with the ſcience of irrigation. I have endeavoured to give an ample example of the capacity of canals in my plan for extending them through the mountains of my native country; and I have only to lament that I can neither attach the power of my anceſtors to my inclination to improve them, or perhaps rouſe my relations, who poſſeſs many of them, to ſee the amelioration which they are capable of receiving. If, however, a more thinking part of ſociety ſhould ſee the ſtate of things with my eyes, and ſhould prove the ſolidity of my theory by practice; there will remain no difficulty as to the reſidue

ſidue of the kingdom: for every body muſt be ſatisfied, that a ſyſtem which ſubdues the moſt ſtubborn heaths and hills, will be competent to extend itſelf into every part of the iſland.

On the ſubject of artificial ſprings I could never enforce too much; but it will poſſibly be more efficient if I leave the reader to his own reflection, and an inſpection of the apparatus.

In the ſubſequent part of my book, I truſt the ſtateſman will find himſelf ſtill more intereſted: it cannot be a matter of indifference to him that there is a great extent of territory which may be irrigated; that the landed income is capable of increaſe; that the value of irrigation can be aſcertained by experience; that the nation poſſeſſes both reſources and ways and means; or that my plan for national improvement can be employed to increaſe the revenue by enriching the individual.

So far as the people of this great metropolis are concerned, I preſume it intereſts them to conquer villainy and fire; and on theſe points I refer them to my plan for the management of criminals, and the example for

for watering houſes, which I have applied to Bedford Square.

Ultimately, I requeſt a notice of my hints towards laying the duſt of roads; this ſubject merits, and has capacity for, more inveſtigation than I have time to give it: and, though it is certainly a luxury worth regarding that we can travel without raiſing the duſt, it is ſtill more important to the health and ſtrength of the noble animal who conveys us, and more ſo to the pocket which muſt pay for the too thoughtleſs deſtruction of him.

It remains as a conſolation, let what may be the fate of my book, that the Board of Agriculture ſeem to correſpond with me in opinion of the ſubject, as their circular letter will atteſt.

In ſubmitting my writings to the public peruſal, I have only to wiſh that they may reap from them as unlimited profit, as tracing theſe ſubjects has given ſatisfaction to

January 18, 1801. *THE AUTHOR.*

CON-

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MEANS

TO INCREASE THE POPULATION, WEALTH, AND REVENUE OF THE KINGDOM, BY VARIOUS METHODS OF WATERING MEADOWS; AND BY AN AGRICULTURAL, COMMERCIAL, AND GENERAL ECONOMY IN THE USE OF WATER.

PRELIMINARY REMARKS.

THERE are three leading principles particularly appropriate to the Kingdom of England, which generate confidence abroad, and afford apparent ſecurity to its territorial poſſeſſions at home, under the diſtinctions of *meum* and *tuum*:—theſe are, the ſtability of its legal maxims; the ſtrict integrity of its commercial engagements; and its long-tried inacceſſibility to a foreign enemy.

Such a baſis as this may enable government to obtain a credit, both at home and abroad, upon all its rational anticipations of *future* eligible profit upon *preſent* undertakings of internal improvements, that are founded upon ſound data.

Recurrence to paſt events will afford an eaſy-diſcovered example, in numerous inſtances, of royal bounties, containing immenſe capacities, from whence public agents find it difficult to gather aid in the time of need, through the unpopular medium of *taxation*: yet poſſibly in many inſtances the individual proprietor is found wholly inattentive to a *paſſive* ſubject matter, which remains uncultivated in his hands; and thus withholds its proportionate ratio of public reſources, for want of an application of the active means of production.

This experience ſeems to urge the propriety of GOVERNMENT ITSELF UNDERTAKING extenſive operations, to render its *own* means productive, in preference to laviſhing them upon men of inactive diſpoſitions; becauſe they will find it eaſier to exerciſe a will over that which they actually poſſeſs, than to ſupport the expence of public operations by reclaiming ever ſo juſt and reaſonable a remuneration from individuals, in a way which neceſſarily encounters as great a variety of opinions, diſpoſitions, and ſelf-conceited intereſts, as it may chance to meet with different faces and complexions.

I perceive a very conſiderable miſtake in

ſome

ſome foreign countries with reſpect to the true *national circumſtances of Great Britain.* The kingdom is believed to be in the higheſt poſſible ſtate of culture and manufactures, and overflowing with population. It is a ſtriking proof of this opinion, that even the Americans, who are ſcions of the ſame root, have built moſt of their late popular misfortunes upon the ſandy bottom of this glaring error. I call it *a glaring error*, becauſe I do not think it requires any abundant penetration to diſcover that Great Britain, under all thoſe advantages of climate and population which have been aſcribed to her, is by no means a perfectly cultivated country; or even within a thouſand years of her zenith in agriculture or manufactures.—A period which, I truſt, will be found ſufficient for *our* occaſions, and for an honourable redemption of the *public debt.*

But probably ſhe may prove in a condition to effect this object in a tenth part of that time, by the *civil* employment of *all* her people even, *partus ſequitur ventrem*, in a way which may afford preſent reſources from proſpects of production in futuro, that may juſtify ſpeculations which will re-

turn fortunes to our grandchildren with certainty.

The eſtabliſhment of a Board of Agriculture has, perhaps, been one of the wiſeſt theoretic meaſures that a nation ever adopted; and from the proſpects of practice, we are not only led to expect the enrichment of the country through the productive ſtimulus of individual competition, but while men of active and liberal minds continue in office, and cheriſh rational deſigns with the means of experiment and execution, we ſhall obtain indubitable proofs of exiſting capacities for an actual improvement of the public reſources; and a new field is laid open for the encouragement of individuals in works of national enterpriſe, through a teſtimony of truths which ſtare the foes of harmony out of countenance, and offer *found* materials for a truly politic ſuperſtructure.

We learn from the agricultural views of the ſeveral counties, which have been wiſely collected to a focal point, under patronage of the Board, that in many of them husbandry has been much neglected, lands remain yet in a ſtate of nature, and the hand of art has but availed itſelf partially of elementary bleſſings.

But

But of all the inſtances of agricultural, houſehold, and commercial economy, which call for the attention of philoſophical obſervation and ſcientific aſſiſtance, none appears to be more conſpicuous than the neglect of an *economical uſe of water.*

Indeed, improvements in reſpect to the various applications of this element, which might be contrived for our better accommodation, ſeem to be loſt ſight of, like moſt other providential bounties, in an imaginary idea of the ſuperabundant infinity of the natural ſupply; and an habitual indifference beyond the ordinary purpoſes which have accompanied cuſtom from early periods of untutored nature.

I have often attempted, in vain, to impreſs men, to whom fortune had been favorable, with certain ideas which I conceived to be intereſting to themſelves and to mankind; and have frequently been rebuffed on the ground of *my original projects* with queſtions whether I had been on the ſpot? or if I had ever ſeen the like carried into execution heretofore? as if ſcientific improvement exiſted without an origin; as if every new place muſt need a new philoſophical principle: or the generous public ſpirit

of boaſted antient Britain had degenerated into *petit imitation* of the effeminate acquirements of modern luxury and faſhion.

In the Southern States of United America, we find it difficult to introduce many valuable improvements, which would be attended with little or no expence, becauſe our anceſtors have handed down to us certain habits which ſerve our occaſions, and that we are loth to depart from; and, I dare ſay, in that country of plenty by nature, men pay ſo little regard to the immaterial concern of what might be done, that if any were ſo bold as to conduct the water to his kitchen by a pipe, leading from a ſpring of much greater elevation than his houſe, he would have the neighbourhood collected about his ears to view the *wonderful Engliſh contrivance*, which had deprived the overſtocked proportion of young negroes of the time-immemorial pleaſure of dancing ten miles per day from ſome diſtant ſpring, under a jug of Father Adam's potation. Nay, if an old woman was to ſubſtitute a Jack weight to move her dinner fan in that vernant climate, the ſee-ſaw of her ſervant's arms would be miſſed by every eye at the table; and ſhe might thank her ſtars that thoſe

blue laws * are obſolete which would have condemned her for a witch!

By *travelling* and by *thinking*, men happily become extricated from this inſulated condition of the human mind; and ſome return freighted with teſtimony of exiſting experiments which have been proved abroad, while others are daring enough to try a market with a new cargo of *freſh-conceived notions*, at the riſque of their time and reputation.

If we ſally forth from this favored ſpot of Albion ſoil, which the hardy ſons of Neptune and Commerce hath ſo lavishly enriched with *foreign* knowledge, we may ſtill find gems of art to bedeck the wreath of Britiſh proſperity: yet if theſe are too far fetched, or dear bought, to ſuit the preſent taſte, we may conſole ourſelves with ſome few home-bred examples within reach of the metropolis, which are worthy an imitation by the nobleman, the gentleman, the merchant, and the farmer.

* Well underſtood in New England.

ANTIENT EXAMPLES OF IRRIGATION.

Let us, however, in the firſt place recur back to the ancients, and explore the regions of early-improved countries; of Greece, of Rome, of Egypt, and of China.

In Beotia it is ſaid that immenſe works antiquity, not now to be traced, have been conſtructed to *drain off*, or to prevent the overflowing of the waters of Lake Copaïs (according to the Abbe Barthelemi); and that theſe are diſtributed in various canals over the whole breadth of the mountain.

There ſeems to be little doubt that theſe aſtoniſhing works were for the purpoſe of *agricultural irrigation*; for if they had been contrived, as the Abbe conceives, to prevent the overflowing of the Lake, pray why did not that Lake drown the country before theſe canals were made? How would it have been poſſible to get at premiſes ſo drowned in the mountain to improve them? Or is there any other probable purpoſe for

* See Phillips's Navigation, p. 2, cited from Anarcharſis.

which

which they could have been conſtructed, but the intereſting purſuit to which I have attributed their deſign?

* Magnificent aqueducts are ſaid to have been conſtructed at Rome at a vaſt expence, for ſupplying that populous city with water. Theſe are reputed to have been variouſly formed, both in reſpect to conſtruction and material; ſome paſſing under ground, ſome above ground, ſome extending a hundred miles, aud built of ſtone, brick, and wood, as occaſion ſerved. Nine of theſe aqueducts are recorded to have diſtributed their contents through thirteen thouſand five hundred and ninety-four pipes, of one inch diameter, perhaps to culinary uſes in part, but greatly to irrigating of gardens and other grounds, as the remains of baſins and fountains ſeem to indicate: nor is it probable, in ſo high a ſtate of ſplendor as Rome enjoyed, that theſe advantages could have eſcaped their notice.

† The works conſtructed by the antient ſovereigns of Egypt for diſtributing the waters of the Nile, ſays Adam Smith, were famous in antiquity; and the ruined remains

* See Phillips's Navigation, p. 3.

† Smith's W. of Nations, Vol. III. p. 33.

of

of ſome of them are ſtill the admiration of travellers. Thoſe of the ſame kind which were conſtructed by the antient ſovereigns of Hindoſtan, for the proper diſtribution of the waters of the Ganges, as well as of many other rivers, though they have been leſs celebrated, ſeem to have been equally great. Both countries accordingly, though ſubject occaſionally to dearth, have been famous for their great fertility: though both were extremely populous, yet, in years of *moderate* plenty, they were both able to export great quantities of grain to their neighbours.

Egypt ſeems to have profited more than any country, not even excepting China, by the fertilizing advantages of irrigation which the overflowings of the Nile afforded, and which were converted to the greateſt profit by the care of its antient governments.

The beauty of the canal of *Faoua*, as deſcribed from *Abulfeda*, by Phillips *, is peculiarly deſcriptive of the benefits of irrigation: "No proſpect can be more enchanting or agreeable. Gardens, groves, and eternal verdure adorn its banks, which are ſhaded by date trees, covered with vines, and em-

* Phil. Naviga. p. 5.

belliſhed

beliſhed with pleaſure houſes." This canal is ſaid to have been cut from the Nile to Alexandria by Ptolemy, to fill the immenſe ciſterns, which are vaulted with great art, and conſtructed in all parts of that city. The numerous magnificent aqueducts * are ſtill almoſt entire, although they are above two thouſand years old; but they are now uſeleſs, as they have been for many ages.

Mr. Phillips gives the following account of the irrigations performed by the inundations of the Nile, on the authority of the Baron de Tot: "The annual inundation of the Nile is the ſource of fertility to Egypt. When the waters have riſen to a certain height, the *khalig*, or grand canal, is opened, by which it is conveyed, by a prodigious number of ſmaller canals, into reſervoirs and ciſterns, to be diſtributed among the fields and gardens as it is wanted. To determine when it has attained to this height, a pillar, called a *Nilometer*, is erected in an iſland oppoſite Cairo, and divided into *pics*, a meaſure of about two feet. According to Baron de Tot, the progreſs of the inundation is obſerved at the nilometer, ſituated at the ſouthern point of the iſland of Rhoda, op-

* Vide Phillips.

poſite

poſite Old Cairo. Public criers, diſtributed in each quarter of the capital, every day make known to the people the riſing of the waters, till they are come to the height proper for opening the canal; by which means they are conveyed to the middle of the city and the ciſterns: but this moment cannot be aſcertained with preciſion, becauſe ſuperſtition prevents the eye of curioſity from approaching the graduated column placed in the centre of the baſin of the nilometer. The cry of "*Oof-Allah*," which ſignifies God has kept his promiſe, proclaims the opening of the canal. Children, bearing ſtreamers of different colours, accompany the crier, and diffuſe a general joy at the certainty of plenty."

It does not appear that the waters at other times ſuffice for the agricultural demand of the country; or that this is the mark of the *greateſt* plenty. To produce that degree, the waters muſt reach the foot of the mountains, and then the criers proclaim, "*Minel Dgebel il Dgebel*," from one mountain to another *.

It appears farther, that there are many

* Phil. Naviga. p. 6, &c.

other

other canals, which are merely under the care of thoſe who are particularly intereſted in their irrigations; and that the culture may be compared to a well-managed kitchen garden.

The lake of *Moeris* was conſidered as one of the moſt wonderful labours of the kings of Egypt; and certainly it was not more wonderful than uſeful.

Different authors, as Herodotus, Diodorus Siculus, Strabo, Pompilius Mela, and Pliny, are ſomewhat various in their accounts of its ſize; but all agree in the immenſity of its capacity and utility, which are the chief points we ſhould contemplate in the example, and which ſhould ſtimulate our exertion, with a bluſh to be ſo far behind ruder ages whom we occaſionally affect to pity.

King Moeris is ſaid to have conſtructed this grand reſervoir by art, with a view to regulate the irrigations of the Nile, as its inundations created a neceſſity. Two pyramids, each three hundred feet high, were erected in the middle of it, upon a proportionate baſe*. Doubtleſs this is an ample

* See Rollin's Ancient Hiſtory, Vol. I. p. 177, Glaſgow Edition, 1795.

proof

proof of its being human workmanſhip; although the moſt creditable account makes it no leſs than ſeven or eight French leagues in circumference.

From this lake there is a canal of eighty five ſtadia, or four French leagues long, which communicates with the Nile by proper floodgates or ſluices; and the charge of ſuperintending theſe was eſtimated at fifty talents, or fifty thouſand French crowns, valued at eleven thouſand two hundred and fifty pounds ſterling*. Its fiſheries are reputed to have afforded an immenſe revenue; but there remains not a ſhadow of doubt, with me, that its powers of irrigation were both the leading motive to its conſtruction, and the ſuperior ſources of wealth with which it abounded: when the nileometer, for inſtance, indicated an overflow or dangerous inundation, the opening of the ſluices muſt have contributed to relieve its preſſure on its embankments; and, if a dearth enſued, it is equally certain that ſo large a body of water muſt have been important to vegetation.

Without entering into the various philoſophical reaſonings of the ſeveral authors

* See Rollin's Ancient Hiſtory, Vol. I. p. 178.

whom

whom I have cited, concerning the riſe and fall of the Nile, it will be deemed enough for thoſe who know the river Miſſiſippi, and can compare the two together, to aſcertain the actual ſtate of its annual inundations. Although travellers differ indeed in ſome degree with reſpect to the period of its riſe and fall, it ſeems tolerably certain that the rains fall in April in Abyſſinia, and that the Nile riſes ſlowly about the month of May: this correſponds pretty much with thoſe ſpring floods of the Miſſiſippi, which may be chiefly aſcribed to the diſſolution of the mountain ſnows.

The foregoing account of the nilometer, from the Baron de Tot, gives the quantum of inundation by a meaſure marked in pics of two feet each, on the column which is erected in the baſin of the nilometer, and which probably correſponds with the pyramids in *Lake Moeris*, which may have been erected there for a ſimilar purpoſe. The Baron has not favoured us with an accurate admeaſurement of the floods, on account (he ſays) of the interfering ſuperſtition; but we are enabled to draw a greater degree of certainty from ſome other hiſtorians. Pliny ſtates the juſt or beſt medium height of

of the Nile at ſixteen cubits flood; each cubit being eighteen inches*. Twelve or thirteen cubits only, are ſaid by this author to threaten a famine; and if the riſe exceeds ſixteen cubits, the freſh becomes dangerous. From hence we may learn the juſt proportions of the embankments which are demoliſhed, in that country of uniform level which conſtituted the premiſes of operation under the kings of Lower Egypt; and, if we may be permitted to leave oracles and ſuperſtition at a proper diſtance behind our ſenſes, we may readily conceive a principle of civil engineering, which is competent to dethrone the river-god of Egypt.

Moſt of theſe writers agree in one point ſomewhat eſſential to be underſtood; that is, that the riſe and fall of the Nile occupies a quarter of the year, in Egypt; but that this loſs of time is made amends for by its fecundating particles and the influence of the ſun. Yet, although the huſbandman of Memphis ſeems to have been releaſed by native fertility from any extreme labour of the plough, we find him vigilant in the duties of irrigation which were enjoined by the national

* Rollin, Vol. I. p. 182.

law,

law, and indicated every where by public indexes or water gages: nor were thoſe who had to water more elevated ſpots than the common ſurface unmindful of mechanical means, tho' very far ſhort of the perfection of Engliſh mechanics. Spiral pumps, aſcribed to the inventive faculties of Archimedes, were applied to purpoſes of Irrigation, both by hand and moved by oxen; and the ſacred record, which has been quoted by Mr. Rollin*, ſeems to imply the uſe of *foot* machines, ſimilar to thoſe deſcribed by Sir George Staunton in his travels in China.

We have here, however, a precedent for the public intervention in works of national irrigation; and are not leſs without ſatisfactory proofs of the economical advantages which are made to flow from the paternal care of thoſe thinking monarchs, who have the peace and happineſs of their people at heart. It is ſaid, that no country on earth poſſeſſes a more fruitful ſoil than that of the Nile; yet it is equally aſcribed to its ſyſtem of irrigation. Numberleſs canals were cut in all directions, to facilitate the overflowing of the lands. The numerous villages which

* Deuteronomy, xi. 10, 13.

ſtood on the banks of the river, had each their canals, which were ſyſtematically opened to let the water into their country. Villages farther at a diſtance had ſimilar conduits, in ſucceſſion, to the extreme of the kingdom; and the waters were conveyed, progreſſively, to places the moſt remote.

Perſons were not permitted to cut trenches to receive the waters till the river was at ſuch a height; nor to open their trenches altogether. They began with opening them in Upper, and afterwards in Lower Egypt, according to rules that were preſcribed in a roll or book, in which all the *gages*, or meaſures were ſet down. By this method the water was diſtributed with ſuch care and economy that it ſpread itſelf over the whole ſurface of the country; and it has been ſaid, of the rains which fall in the upper country, not a tenth part reaches the ſea.

It is ſaid, that at two ſeaſons of the year Egypt exhibits a proſpect, which is yet unrivalled on the face of the earth*; how far the Miſſiſippi may in future vie with it, is a point yet undetermined. If a man aſcends a mountain, or one of the Pyramids, in

* See Rollin, Vol. I. p. 187. Seneca Nat. Queſt. L. iv.

July

July or Auguſt, he beholds a vaſt ſea, in which numberleſs towns and villages appear, with ſeveral cauſeways leading from place to place; the whole interſperſed with groves and fruit-trees, whoſe tops are only viſible; and the ſcope is bounded by mountains and woods at the moſt diſtant view which the eye can diſcover.

On the contrary, in the months of January and February, when winter elſewhere prevails, the whole ſpace is a vaſt expanſe of beautiful meadows, beſpangled with flowers, and enlivened by flocks and kine, and by numerous herdſmen and gardeners.

Is it not worthy of ſuch a country, that the peaſant ſhould hold an honourable name; and that thoſe ſervile occupations of the herdſman and farmer, which alone afford the means of diſſipation to higher ranks, ſhould have an honeſt pretenſion to the public eſteem?

" It will be always ſo with every kingdom, ſays Mr. Rollin*, whoſe governors direct all their actions to the public welfare. The culture of lands, and the breeding of cattle, will be an inexhauſtible fund of

* Rollin's Ancient Hiſtory, Vol. I. p. 220.

wealth in all countries, where, as in Egypt, theſe profitable callings are ſupported and encouraged by *maxims of ſtate policy*. And we may conſider it as a misfortune that they are at preſent fallen into ſo general a diſeſteem; though it is from them that the moſt elevated ranks, as we eſteem them, are furniſhed, not only with the neceſſaries, but even the delights of life."

Again, ſays the *Abbe Fleury*, in his work on the manners of the Iſraelites*, "It is the peaſant who feeds the citizen, the magiſtrate, the *gentleman*†, the eccleſiaſtic: and whatever artifice and craft may be uſed to convert money into commodities, and theſe back again into money; yet all muſt ultimately be owned to be received from the products of the earth, and the animals which it ſuſtains and nouriſhes. Nevertheleſs, when we compare men's different ſtations of life together, we give the loweſt place to the huſbandman: and, with many people, a wealthy citizen, enervated with ſloth, uſeleſs to the public, and void of all merit, has the preference; merely becauſe he has more

* Cited by Mr. Rollin, Vol. I. p. 220, 221.

† See Doctor Franklin's Tale of the Negro's Hog!

money,

money, and lives a more eaſy and delightful life."

"But let us imagine to ourſelves a country where ſo great a difference is not made between the ſeveral conditions; where the life of a nobleman is not made to conſiſt in idleneſs and doing nothing, but in a careful preſervation of his liberty, that is, in a due ſubjection to the laws and the conſtitution; by a man's ſubſiſting upon his eſtate without any dependance, and being contented to enjoy a little with liberty, rather than a great deal at the price of mean and baſe compliances—A country, where ſloth, effeminancy, and ignorance of things neceſſary for life, are held in their juſt contempt, and where pleaſure is leſs valued than health and bodily ſtrength—In ſuch a country it will be much more for a man's reputation to plough, and keep flocks, than to waſte all his hours in ſauntering from place to place, in gaming, and expenſive diverſions."

* La Compte ſays, that although China was not of itſelf a fruitful country, its canals would make it ſo. "One large canal," ſays he, "generally runs through every

* See Philips's Naviga. p. 11.

province; and a vaſt number of ſmaller ones are cut from that large one; which, again, are ſubdivided into ſtill ſmaller ones, or rather rivulets, that end at ſome village or great town. Sometimes they diſcharge themſelves into a lake, or large pond, from whence all the adjacent country is watered; ſo that theſe clear and plentiful ſtreams, embelliſhed by a great number of fine bridges, bounded by great and convenient banks, equally diſtributed through vaſt plains, covered with a numberleſs multitude of boats and barges, and crowned (if I may uſe the expreſſion) with a prodigious number of towns and cities, whoſe ditches they fill, and whoſe ſtreets they form, at once render that country the moſt fruitful and moſt beautiful in the world."

" * The Chineſe not only make canals for the convenience of travellers, but they alſo dig many others to catch the rain water which comes down from the mountains, and with which they water the fields in time of drought—more eſpecially in the northern provinces. During the whole of

* See Sir G. Staunton's Embaſſy, Vol. II. p. 473, 482, 499, 517, &c.

ſummer

ſummer you may ſee the country people buſied in raiſing this water into abundance of ſmall ditches or channels, which they cut acroſs the fields. In other places they contrive great reſervoirs of turf, the bottom of which is raiſed above the level of the ground about it, to ſerve them in caſes of neceſſity: beſides, they have every where in the provinces of Xenſi and Xanſi, for want of rain, certain pits, from twenty to a hundred feet deep, from which they draw water with incredible labour. If by chance they meet with a ſpring of water, it is worth obſerving how carefully they huſband it: they ſuſtain it by banks in the higheſt places; they turn it here and there a hundred different ways, that all the country may reap the benefit of it; they divide it, by drawing it by degrees as every one hath occaſion for it; *in ſo much, that a ſmall rivulet, well managed, ſometimes diſpenſes fertility to a whole province*.*"

It is needleſs to dwell longer on examples of ancient irrigations, or their infinite productions. The memoirs of Major Rennel, the works of Duhalde, Le Comte, Sir George

* Philips's Naviga. p. 14.

Staunton, and others, give numerous examples on the Ganges, Burrampooter, &c.; and many inſtances of importance are recited in my firſt volume of the Political Economy of Inland Navigation, Irrigation, and Drainage, &c.

IRRIGATIONS IN SPAIN.

In many parts of Europe there are inſtances of agricultural irrigation, highly worthy of Britiſh imitation.

In Spain, where ſome are wont to ſuppoſe men live in wretched indolence and poverty, becauſe they differ from themſelves in habits, we find examples of *induſtrious economy in the uſe of water*.

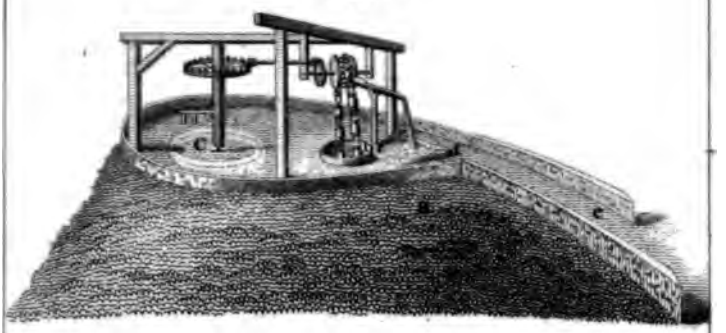
Many towns exhibit noble ſpecimens of ornament and uſe in this reſpect; and ſome have even venerable remains of yet perfect Roman aqueducts, aided by Mooriſh and modern repairs.

Almeida's, or public walks, planted with poplars, are to be found in moſt of the larger towns, and few of theſe are without fountains of pleaſure and of uſe; although many

The Noria of Spain.

To face page 25.

Fig. 1.



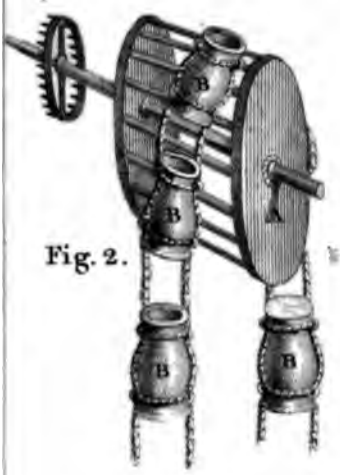


Fig. 2.

Fig. 3.
One of the Earthen Jars.

Fig. 1.

a. *The Mound of Earth.*
b. *The Noria-well.*
c. *Geer for the Cattle.*
d. *The Reservoir.*
e. *The Road up the Mound.*

Fig. 2.

A. *The Sprocket Wheel.*
B. B. B. B. *Earthen Jars, which descend into the Well, by means of an endless Strap of Ropes.*

many of them are ſupplied by the application of animal labour to fill the reſervoirs, from whence ducts are diſtributed abroad to ſupply the calls of animal thirſt, and the abſorptions of irrigation.

Reſervoirs for irrigation are generally contrived, in Spain, upon what is termed the *Noria* plan.

The *Noria* conſiſts of a mound of earth, raiſed above the ſurface of the ground to a convenient degree of elevation, for conducting channels to the various parts of the ground which is intended to be irrigated.

This mound is walled round with brick or ſtone to keep it compact, or with earth and ſtraw rammed into a *caiſſon*, in the Mooriſh manner, ſimilar to the cheaper method of which the poorer *villages* are conſtructed: ſuch, for example, as the famous village of Puerta la Piche, where Don Quixote is ſaid to have received ſome of his honorary diſtinctions.

Upon this mound a reſervoir is elevated, together with a machine, worked by cattle, for the purpoſe of raiſing water to the reſervoir, from a well which is dug below it in the common way; or, where a convenient

cut

cut can be made to ſome adjacent river or ſtream, the water is conducted *through an arch*, opening a communication between the bottom of the *Noria-well* and ſuch convenient ſupply.

The method by which the water is then lifted is, ſimply, by an endleſs ſtrap; compoſed of two ropes paſſing over a ſproket wheel at the upper extremity, and hanging looſe into the water which is contained in the well below. Between theſe ropes a ſucceſſion of earthen jars are tied at proper diſtances, and are thus emptied at each and every revolution into a trough, which conveys the water into the reſervoir.

I think in the plains of La Mancha, near Manzanares, I counted about forty of theſe Norias at once in the cultivated grounds, which appear to be applied wholly to the purpoſes of irrigation: but as there is a grand canal, partly completed, within a ſmall diſtance of them, it is to be hoped the time is not far diſtant when theſe poor people will have much of this labour ſaved; and it is but juſtice to the king of Spain to ſay, that he ſeems far from being remiſs in a paternal care for his people, or a deſire to better

better their condition, ſo far as conſiderations of political ſafety may permit him to do it.

With regard to the mere ornamental improvements which are to be met with in his Catholic majeſty's gardens at his ſeveral palaces, and at the palaces of the biſhops, and convents of the clergy, (who have been ever mindful of good things in their way to Heaven) I ſhall leave them to the deſcription of a more fanciful pen, and content myſelf with obſerving a few particulars which admit of cheap and uſeful introduction into other countries, where I do not find them in practice, or where I think they may be improved upon to general advantage.

In the King's gardens at the palace of Sevilla, my attention was ſuddenly awakened by the ſound of a trumpet, which ſeemed to be low and rudely blown; and which I immediately perceived to be that held in the hand of the figure Fame, which juſt gave me timely notice to jump upon a bench out of the way of an artificial ſhower in reverſe, that proceeded from under my feet, and performed the three-fold office of irrigating and cleanſing the adjoining borders and walks.

The contrivance is thus conſtructed: an aqueduct, which receives the water from a

canal that collects its ſupply about ſix miles off, in the country, and is carried upon arches elevated upon pillars, forming a kind of colonnade, by the ſide of an old Roman way for about half a mile, from a corn mill to the city, paſſes cloſe by the palace; and ſupplies the baths "of the antient Queens," *(perhaps of the haram)* and the fountains in the gardens, which appear to have been repaired by the Moors, upon a foundation laid by the Romans, as is evidenced by ſeveral ſpecimens of antient ſculpture, both coloſſal and characteriſtic, which were dug out of the gardens, and are ſtill preſerved in the palace as his majeſty's property.

From this aqueduct there is a pipe which communicates into the wall of the adjacent fountain, which preſents a front at the head of the centre walk of the ſecond garden, that leads through evergreens to orange groves, to a labyrinth, ſeveral ornamental temples, &c.

The front of this fountain and ſome part of one ſide wall, which is beautifully covered with oranges as a wall fruit, are of a ruſtic groteſque conſtruction, with the water trickling through the artificial rock in imitation of nature. Upon the ſummit of this ruinated

nated wall ſtands the figure of Fame; and the chief fountain is ſo contrived, that when the water ſuddenly fills its pipes from the aqueduct behind it, the air is forced through the trumpet by hydroſtatic preſſure, and produces a ſound which diminiſhes gradually as the vacuum is filled.

This ſound is, I preſume, intended as the ſignal for playing off the fountains; which is alſo the ſignal for his majeſty's approach, if he deſigns to be preſent on public occaſions: and it is highly probable that the original invention kept pace with a period when Kings had little more to do than to laugh at their ſubjects for getting ſouſed; or hazard their lives as trifles in daily tournaments of pleaſure. But I think I have ſeen Charles IV. partake a wetting with his ſurrounding ſubjects for experimental purpoſes of more honor to his heart.

Among the numerous fountains in his Catholic majeſty's gardens at Aranjuez, I noticed one which is conſtructed upon a ſimilar principle with the above, and which calls my remembrance to its ſimplicity and utility. The principle of operation is the ſame with that of every other ſimple fountain, and depends upon the gravity of the head ſupply,

or

or preſſure of water: but what appears to me to be of moſt moment is, the contrivance of its ducts, which have a cheap and eaſy capacity for irrigation, and may, with very little additional expence, be applied to many other hydraulic purpoſes.

They conſiſt of leaden pipes paſſed from the reſervoir down each ſide of a flagged walk, and perforated at proper diſtances with gimblet holes, which penetrate through the wood they are caſed with into the hollow of the pipe. This circumſtance, regulated by the angle of elevation, enables a diſtribution of the water into every part of the walk by the turning of a cock, and might be advantageouſly uſed for the purpoſes of horticulture, agricultural irrigation, or diſtinct conduits for waſhing the ſtreets of populous cities, thus preſerving their harbours from the riſk of ſilting.

If ſuch pipes were laid along the ſides of the city road, leading from Paddington, through Pentonville, &c. I think a couple of turncocks would lay the duſt at much leſs charge than the hire of the carts which are employed in this ſervice, with ſuch opportunities of evaſion, that the boys who drive them are ſuffered to gull the public, and laugh

laugh at them for being the dupes of a deceptive routine, wherein they ſtudy only to wet the middle of the road, for the ſport of duſting thoſe who walk the foot-paths, near the dirty-neglected edges.

In addition to the methods of irrigating in Spain, more or leſs of which is performed through aid of the fountain ducts in moſt inſtances, they ſeem to be attentive to the accommodation of animal thirſt, by the conſtruction of watering places by the way ſide; and ſome whereof, (particularly one which I obſerved in the dividing ridge between the waters of the Duero and Ebro rivers, not far from Brevieſca, in the province of Burgos) have conduits, of ſome miles in length, from a more elevated ſummit level.

IRRIGATION IN AMERICA.

I had written moſt of what I ſhall notice in reſpect to irrigation on the other ſide of the Atlantic ocean, before the ſecond volume of *Communications to the Board of Agriculture*, publiſhed this year, 1800, came before the public. It is, therefore, an after view of my manuſcript, which diſcovers to me how widely I have differed from the account of American irrigation, communicated by Mr. Strickland of York, whom I perſonally know, and perſonally eſteem. I premiſe this circumſtance, and ſhall alſo let my work ſtand as it is, leſt I ſhould be conceived to be influenced by a malevolent ſpirit in the contradictions I feel myſelf bound to maintain without retraction; both now, in the caſe of irrigation, and hereafter, in ſome other inſtances where a regard to truth and juſtice renders it my duty to volunteer it againſt thoſe who may have practiced impoſitions on Mr. Strickland, either through a want of information, or a deſire to gratify a ſplenetic prejudice, too circum-

circumſcribed, I fear, to extend its inquiries with liberal trouble.

I ſhall make no other apology for this diſſentient, than one which *reaſon* will, I doubt not, admit: *a diſintereſted perſon, born in England, and having thirty years perſonal acquaintance with the premiſes and people which are ſpoken of; and one who has been twenty-five years in public life there, and ſo long acquainted with the extreme frontier of the back parts, will be as likely to know the facts which concern it, as the caſual informant of Mr. Strickland's tour.*

It will be obſerved, however, that Mr. Strickland's perſonal obſervations on American irrigation apply chiefly to a part of America which I have not explored; and as the frontiers of the Southern ſtates are, perhaps, not within his journal, it may be of ſome importance to the preſent harmonic diſpoſition of the two countries, that, together, we may be able to render the communication more expanſive.

* Mr. Strickland tells us *(as far as he could*

* *The Agricultural Report of Mr. Strickland's own county, York, claims the originality in that county, within fifty years back.*

learn) " Irrigation is known only in two parts of the United States, and in neither of them practiced to any conſiderable extent. It offers no material circumſtances worthy of imitation, nor is it conducted on any principles that are not at this time much better underſtood in this country," meaning *England.* " *Connecticut* is the moſt Northern ſtate where it is met with: the practice was probably * *carried thither* by the firſt ſettlers, moſt of whom emigrated from the counties in the Weſt of England, where it is now beſt underſtood; but they do not appear to have kept pace in improvement with their kindred on this ſide of the Atlantic.

The German tract in Penſylvania is the other part where it is practiſed, and the knowledge was carried thither from Flanders or Germany. Two crops of hay are always cut where lands are thus artificially watered.

The law has ordained the right of the water to be in him who poſſeſſes the ſpring head, or the higheſt part of the ſtream; he may conſume what quantity he pleaſes, but

* Communications to the Board of Agriculture, Vol. III. p. 165.

muſt

muſt convey the remainder into the antient channel; he muſt not divert the ſtream or waſte the water to the prejudice of thoſe below him. The mode of applying the water is different in the two ſtates: in Connecticut it is turned on the land as ſoon as the weather begins to be warm in the ſpring; but it is not allowed to flow for more than twenty-four hours at a time: it is then taken off for a few days, then turned on again for twenty-four hours; and ſo on, till the meadow is nearly fit for cutting: immediately after which, it is applied again in like manner for a ſecond crop, and then again to force the after graſs in autumn; but it is always found to have the greateſt effect upon the ſpring crop.

In this ſtate they alſo apply water to their lands in another very different unuſual manner: they flood great tracts of low meadows, ſituated on running waters, juſt before the winter ſets in, to the depth of two or three feet, by ſtopping the courſe of the ſtream, and let them thus remain covered till the ſpring, *in order to keep them warm, and defend them from the froſts.* Theſe lands produce the following year a conſiderable quantity of coarſe hay, which, in conſe-

quence of the fine climate in ſummer, being very well got, is eagerly conſumed by the cattle in winter: after the hay is cut, theſe fields for the remainder of the year are paſtures.

In Penſylvania the water is uſually turned on the meadows about the middle of April, and is allowed to flow about two months; a few days after which, the ground having got dry, the crop is cut: as ſoon as the crop is off, the water is again turned on for three or four weeks, or till the land gets a ſufficient covering to defend itſelf from the ſun, at that ſeaſon very powerful: a ſecond crop is then ſoon ready for the ſcythe; after which the water is allowed again to flow over it, till within a ſhort time before it is wanted for paſturage, when it is turned off, in order that the ground may ſo harden, as not to receive injury from the treading of cattle. Which of the two methods of applying the water may be moſt productive, I know not, not having ſeen the meadows of Connecticut in the ſummer ſeaſon; but thoſe of Penſylvania bear abundant crops.

Water iſſuing from lime-ſtone in Penſylvania is thought preferable to any other running ſtream; but the warm, half-putrid water

water from a reſervoir made for this purpoſe, which is not unfrequent, or a mill dam, in which it becomes ſoft, ſlimy, and muddy, is greatly preferred to all others; water of this kind, at this ſeaſon of the year, will in Penſylvania be heated as high as 85° by Fahrenheit's thermometer, and muſt have a great effect in forcing vegetation.

No art is uſed beyond a channel, carried on a level, as far as it can be done conveniently, over one ſide of which it can flow: no means have been taken for raiſing it above its natural level, which in many places might be performed with much facility.

Since the introduction of clover, theſe meadows are falling faſt into diſuſe, many of them having been already ploughed up, and converted into tillage: no farther improvements are therefore hereafter to be looked for in this branch of rural economy."

So far Mr. Strickland's account of American Irrigation extends. I ſhall only here remark, that a longer ſtay in the country, and a more minute inveſtigation, would have diſcovered to him, in the Southern and Weſtern ſtates, a few ſolitary examples, at leaſt, of improvements in irrigation, for which

the people of thoſe countries are no ways indebted to the tranſplanted genius of South Britain. In South Carolina and Georgia, the rice plantations form an immenſe irrigation: he might have found watered meadows of tolerable luxuriance in the fork of Broad River and Saluda, commonly called the Dutch Fork. In North Carolina, at the Mornavian towns, at Ramſour's mills, and in many other places, he might have found both common level, and lifted irrigations, performed by cheap and ſimple wheels; and in travelling the main road into the Tennaſſee country, he could not have avoided ſeeing the very wheel which would accommodate the wiſhes of the Board of Agriculture: future travellers will find this at Stover town, and many places throughout the back ſettlements of Virginia; and the practice of irrigation will be found in the counties of Berkley, Frederick, Shannandoah, Rockbridge, Bottetourt, Montgomery, Wythe, Waſhington, and the Tennaſſee counties; reaching from Potomack to the borders of Georgia.

I proceed to the account I had given heretofore without alteration; and if Gentlemen, who may hereafter ſeek for irrigation in the Weſtern ſtates of America, will remember to look

look for it on Reed creek in Wythe county, or at Captain Craig's, near the town of Abingdon, they will find a lifting wheel worth their imitation, in regard to cheapneſs and performance.

In the interior parts of America, the Germans and their deſcendants are particularly attentive to economy in the uſe of water; and when a Dutchman penetrates into thoſe countries to ſeek a domain eſtabliſhment for his family, a good mill ſeat and a ſtill ſeat are its two primary recommendations: next to theſe he eſtimates the meadow ground; and if nature affords him a water-fall of nine inches perpendicular height, he contrives to elevate it to as many feet, and diſtributes it round the higher trenches of his meadow, and to culinary purpoſes, by the help of a ſimple invention, which he terms his lifting wheel.

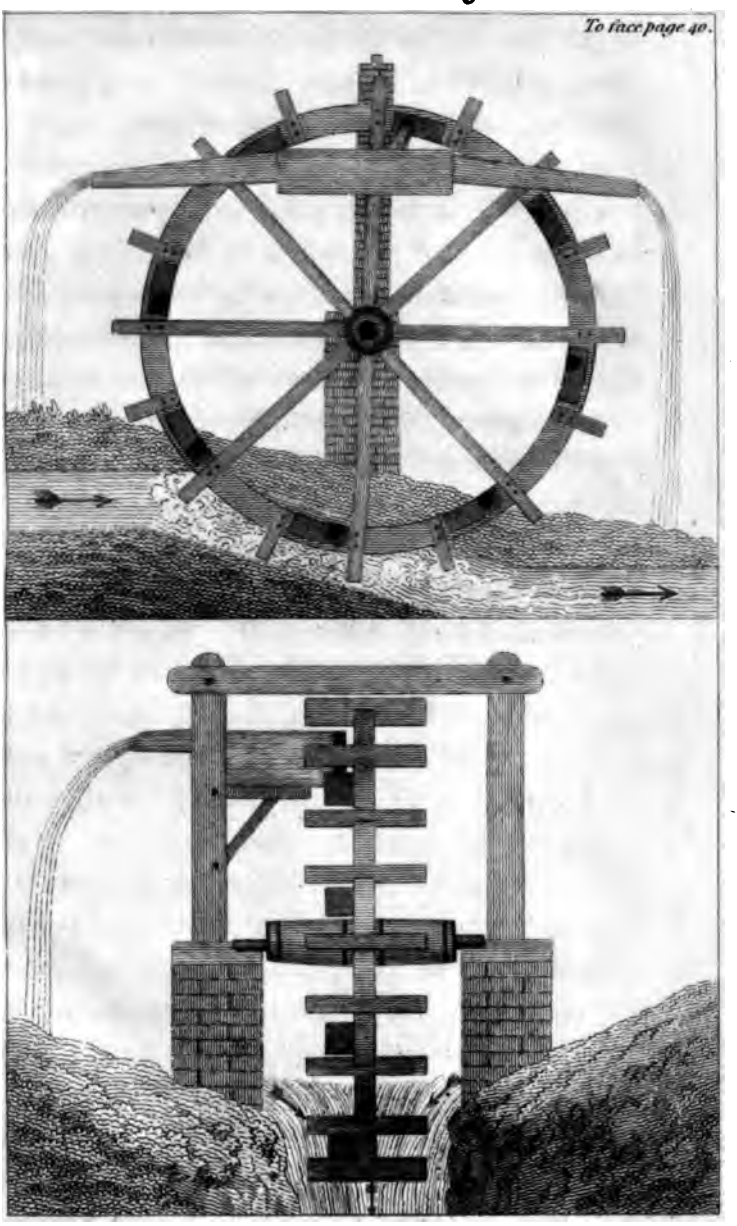
A lifting wheel is uſually conſtructed of common deal, oak, or any other boards nailed together in the readieſt way which occurs, to approximate ſuch material as you may happen to have, to the ſhape of a circle, whoſe diameter is equal to the perpendicular height of the ſummit level to which you would raiſe your water at a ſingle operation;

allowing for ſo much thereof as ſhould dip into the ſtream to fill your buckets, and ſo much as ſhould paſs above the uppermoſt trough to diſcharge the water from them.

This ſhape is then reduced to an exact circle by the means of a line and chalk extended from its centre, and the ſurplus plank being hewn down to the ſcribe of the circle, an axis of about two feet ſix inches in length is fitted to it with arms of the ſame plank, and two ſmall iron gudgeons to turn upon. Flutter boards are then fitted on with the ſaw, and cleated at convenient diſtances; with a cloſe box between every ſecond and third of them, nailed upon the rim of the wheel. Theſe boxes (by ſome termed gaining and looſing buckets) have two apertures or holes for receiving and diſcharging the water; and as the bucket is immerſed in the ſtream below, by the power of this little rapid acting upon the ſucceſſive flutter boards, the water is taken in at one hole, and diſcharged out of the other, as the wheel revolves it over the trough above. Theſe are ſometimes formed out of a worn-out cart wheel fixed upon an axis, which anſwers for a ſmall elevation. The neareſt deſcription of an invention ſimilar to this wheel, which I have

Section & Front View of the German Lifting Wheel used in America.

To face page 40.



have met with in any of the Engliſh authors, is that deſcribed by Mr. Ferguſon, in page 152 of his Lectures, under the name of the *Perſian* wheel. This wheel of Mr. Ferguſon's acts in the ſame manner by a flutter board, and diſcharges by ſtriking the bucket againſt a pin at the ſummit point of its revolution: but the German lifting wheel has greatly the ſuperiority in reſpect to ſimplicity and cheapneſs, which brings it within the reach of every man who occupies land; and, poſſeſſing equal power with the Perſian wheel, may be conſidered ſteadier in the fixture of its flutter boards, and the beſt medium between this and the ruder contrivance deſcribed by Sir George Staunton, as one applied to ſimilar purpoſes in China.

IRRIGATION IN FRANCE.

Mr. Young, in his Three Year's Tour through France, publiſhed in 1792, gives a chapter wholly upon the irrigation of that country, from whence many good lights may be derived.

As this work may not happen in the hands of all my readers, I will beg the indulgence of a few extracts from it*. From Limoſin to Limoges, ſays that popular agriculturiſt, every ſpot of land in the mountains is watered that is poſſible; and with ſuch attention, as marks how ſenſible they are of the importance of this improvement. The water is conducted very high up the ſlopes of the hills; and in ſeveral inſtances I was at a loſs to conjecture from whence it was brought. But in the low flat bottoms it is badly done, with lines of ruſhes along the carrier trenches, and little attention paid to the conducting of the water away ſpeedily enough.

* Young's Tour, p. 363.

Near

Near Gange, we are told in the ſame work and page, a ſolid ſtank of timber and maſonry is formed acroſs a conſiderable river between two rocky mountains, to force the water into a very fine canal, in which it is, on an average, ſix feet broad by five feet deep, and half a mile long; built, rather than dug, on the ſide of the mountain, juſt under the road, and walled in like a ſhelf—a truly great work, equally well imagined and executed! A wheel raiſes a portion of the water from this canal thirty feet, by its hollow perripherry. An aqueduct, built that height on two tire of arches, receives the water, and conducts it on arches built on the bridge, acroſs the river, to water the higher grounds; while the canal below carries the larger part of the water to lower fields: an undertaking which muſt have coſt conſiderable ſums.

* Within a few miles of Gange is another ſimilar irrigation; the water is taken from the river in the ſame manner, and lifted equally high by another wheel. The whole way through theſe mountains the exertions in watering are prodigious; there is not an

* Young's Tour, p. 364.

inch,

inch, capable of being irrigated, over which water is not thrown, conducted on the ſlopes of the mountains every where poſſible.

* At Moulins, Monſ. Martin, the gardener of the royal nurſery, who is from Languedoc, waters his garden after the manner of that province. A Perſian wheel of buckets raiſes the water from a well twelve feet, the receiver being placed ſo low as to have five or ſix of the buckets emptying at a time; and very little water is loſt, not the twentieth part, according to all appearance. A horſe turns the wheel. It raiſes two hundred poinçons, each of two hundred bottles an hour. The water is conducted by ſmall channels to all the beds that want it.—I ſhall have occaſion to notice more of Mr. Young's account in another place.

As theſe, however, are improvements beyond ſea, and there may be men who do not chooſe to truſt their monies or belief farther than occular demonſtration upon old Engliſh terra firma, I beg leave to call their thoughts to a few examples in daily practice in their own country.

* Young's Tour, p. 364.

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IRRIGATION IN ABERDEENSHIRE:

Its Benefit to Agriculture.

Doctor Anderſon, in his report to the Board of Agriculture on the ſtate of huſbandry in Aberdeenſhire, ſays, * there is perhaps no beneficial practice in agriculture which has been ſo generally neglected in Great Britain as that of watering land. Its fertilizing effects have been ſufficiently experienced in our climate to demonſtrate, that great benefits might be derived from this application of that uſeful element; but we are as yet unable to make even an approximated eſtimate of what the amount of theſe benefits might be, becauſe we know ſo little of the variety of caſes in which it might be applied, or of the preciſe nature of its meliorating effects. Perhaps the application that has been made of it in Aberdeenſhire goes farther to point out the nature of theſe future and diſtant effects, than that of any other part of Britain. It is proved

* Rural Economy of Aberdeenſhire, p. 166.

by

by the practice there, that if a ſtream of water is allowed to flow over the ſurface of a heath-covered moor for a conſiderable length of time, that moor not only looſes the power of producing heath, but it gradually acquires the faculty of producing graſs in abundance, as well as corn, and various other crops that, in its natural ſtate, never would have been reared upon it; and that it not only is enabled to produce theſe crops in conſequence of the moiſture it furniſhes at the time they are growing, but that theſe effects continue after the water itſelf is withdrawn; and that of courſe it operates as a manure, which communicates a permanent fertility to the ſoil that never can be loſt, except by bad management at ſome future period.

In this point of view it would appear, that every drop of water which is allowed to run into the ſea, without having been firſt ſpread upon the ſoil to fertilize it, is a waſte of ſo much valuable manure; and that thoſe who ſuffer it thus to go to waſte, are guilty of nearly a ſimilar crime as thoſe who bury their dung in pits under ground.

They are, however, in the firſt inſtance the more excuſable, becauſe in many caſes the diviſion of property interrupts the progreſs

greſs of water-courſes; and particular ſervitudes, that have been eſtabliſhed in barbarous times, prevent men from availing themſelves of a bleſſing, that otherwiſe might have been within their reach. If it be true, as Swift aſſerts, "that the man who can make two blades of graſs grow where only one grew before, deſerves more applauſe than all the warriors and politicians that ever were born;" it will naturally follow, that thoſe who neglect to do this, when it is within their reach, are equally intitled to blame for miſconduct.

Water is peculiarly adapted to the improvement of hilly countries; becauſe theſe from their ſituation admit not of any other kinds of manure being carried to them: for very few hilly countries can be found, where, as in Derbyſhire, other manures can be ſpread upon them.

But, were a large ſtream of water, ſuch as the Don or the Dee, taken off at a conſiderable height from the ſea, and conducted in a level direction for many miles, it would gradually riſe to a great height upon the hills, ſo as, where the ridges of hills were not diſcontinued, to riſe even to the tops of very high mountains; all the ſurface of which,

which, below the level of this ſtream, would gradually be converted into graſs inſtead of heath, were that courſe continued forward even for many miles. And though the whole of that ſoil could not be fertilized at once, yet every moment would be adding to the ſum total of that fertility; ſo as in time to make the whole ſurface of the moſt barren heath-ground as fertile as the moſt luxuriant ſoils.

And were the owners of ſuch ground, in the courſe of conducting theſe canals, to avail themſelves of ſuch occaſional hollows between the mountains as might preſent themſelves below the level of its courſe, the outlets from which could admit of being dammed up, ſo as to be made uſe of as reſervoirs to receive the ſurplus water in time of floods; for the purpoſe of being afterwards diſtributed by lower channels to ſuch fields as were within their influence—the effect would be much augmented. It is in this way that the natives of India form reſervoirs, by them called *tanks*, to be filled with water during the rainy ſeaſons, and afterwards diſtributed over their rice-fields. Some of theſe tanks are many miles in length, and in breadth and ſhape adapted

to

to the nature of the ground: nor are theſe tanks unproductive of even human food; for beſides fiſhes, which are there caught, the thrifty natives plant their bottoms with the *nymphæ aquatica*, whoſe large roots furniſh a conſiderable part of their ſuſtenance; and though we are not as yet in poſſeſſion of any aquatic plant in this climate which could be employed for that purpoſe, yet were the fields that are thus occaſionally employed as reſervoirs, laid ſufficiently dry when the waters are off them, they would become very productive of herbage, and much more profitable to the farmer than ever they were in their natural ſtate. I know a hollow that is employed for half the year as a mill-pond, and the other half year as a meadow, which lets at a very conſiderable rent.

So far Doctor Anderſon, who, in ſpeaking again concluſively concerning ſome of the works for public irrigations in France, on the authority of Mr. Young, who I have herein before cited, farther remarks, that as ſuch public works have hitherto unfortunately been confined to warm countries, men have generally adopted the idea that the only uſe of ſuch irrigations muſt be to give

moiſture to plants when growing, as the great heat of the climate would deprive them of the requiſite humidity; and that, of courſe, in ſuch moiſt climates as Britain, whoſe plants are rarely killed with drought, they cannot be wanted. He ſtates the fact as clear, however, and gives the practice of Aberdeenſhire as an unexceptionable proof, that water, duly ſpread over the ſurface, and judiciouſly managed, acts always as a permanent manure, that is equally calculated to fertilize the fields and mountains in high latitudes, as to render luxuriant the crops in the vales of torrid regions.

* Let not Britain, then, ſays he, boaſt of her attainments in agriculture, or conſider her fields as nearly as productive as they might be rendered, while ſuch immenſe quantities of water are ſuffered to flow into the ſea, without having ever been employed to fertilize her fields in the ſmalleſt degree.

In theſe poſitions he perfectly accords with my ideas; nor can I perceive any reaſonable excuſe that can be offered for a farther delay of the infinite advantages which may be made to flow from ſo powerful a

* Rural Econ. of Aberd. p. 170.

ſource

ſource as that of national irrigation. That is certainly not among the leaſt agricultural acquirements which enables us to eradicate a uſeleſs heath, and to render it abundantly productive of graſs or corn by the ſimple application of water as a manure: nor can any thing be more laudable than a public attention to theſe eaſy means of multiplying the comforts of the community. But we ſhall explore them to greater advantage in the detail through which we are about to proceed; and I flatter myſelf that the convictions from thence ariſing will be productive of many experiments, and of ultimate happy tendency.

IRRIGATION IN LINCOLNSHIRE.

Sir John Sinclair (fortunately before my work goes to preſs) has obligingly furniſhed me with a reference to ſeveral inſtances of advantageous irrigation; both of the kind which we are to conſider as ſimple watering, and that of a more compound nature, termed warping; which, from the circumſtance of its forming ultimately the whole ſoil or ſu-

perſtratum, ſeems decidedly to merit preference as the moſt excellent in the catalogue of liquid manures.

It gives me pleaſure to find, among the ſpirited improvements of the thriving county of Lincoln, an example of irrigation under a head where men of inveſtigation alone will, perhaps, look for it: for it ſeems very inconſiſtent with vulgar perſuaſion and prejudice, that one ſhould ſeek the means of communicating water as an artificial manure, where nature demanded a very laborious operation to drain off a redundancy of moiſture*. Mr. Hoyte, diſcountenancing haſty deciſions on the outward appearance of nature, has been at ſome pains to analize the effects of irrigation; while, by diſcovering, perhaps, the true principles of its beneficial influence, he has ſucceeded in a combination of watering and drainage which proportions the degrees of moiſture, and the fertilizing qualities which accompany them, to the ſucceſſive calls of vegetation; and applies both to the enrichment of the ſoil. I ſhall reſerve the ſubject of warping for its more appropriate place in this work, and, at pre-

* See Lincolnſhire Rep. p. 239.

ſent,

ſent, take a farther view of the inſtances I am referred to under the more ſimple head of watering.

Mr. Hoyte, of Oſbornby, of whom we have juſt had occaſion to ſpeak, has given farther ſpecimens of his ſuperior ſkill and ſpirit in this kind of improvement, by taking to himſelf an allotment of poor land, for the laudable purpoſe of convincing unbelievers in the theory of agriculture, how very far it is poſſible to practice irrigation with profit. He has availed himſelf of the undervalued reſource of *catch-water drains*, and has irrigated fifty acres at an expence of about fifty pounds*. This improvement ſucceeds to his wiſhes, but it is yet of too recent a date to authoriſe a deciſive account of its product. This Gentleman alſo has obſerved and put in practice a leading maxim in irrigation, which ſeems every where to obtain: he takes care to continue his water (as near as practicable in retaining its nutritious particles) in a conſtant ſtate of activity. His method is to water three or four days, and then ſhift. I apprehend, however, that where irrigation is uſed in a warm ſeaſon, a

* See Agricultural Report of Lincolnſhire, p. 275.

different practice muſt be adopted; and, in this reſpect, a few experiments will be found the beſt preceptor to govern the variance of ſoil and climate. Mr. Hoyte uſes irrigation in the time of froſt for the purpoſe of deſtroying ſedge; which, in his experiment, is ſucceeded by the appearance of white clover.

Mr. Young ſtates the produce gained, in this inſtance, at a ton of hay, and fifteen ſhillings ſpring-feed per acre, with nearly the ſame quantity of after graſs. To this we are to add the advantages of early feed for an increaſing ſtock, and the enrichment of the farm by the proportionate accumulation of manure.

In the Weſt Riding of Yorkſhire, there are ſome inſtances of great advantage derived from irrigating, watering, or floating fields, as it is there termed. Mr. Walker, of Crowſneſt, ſeems to have ſtudied the eaſieſt mode of commanding his water; and Mr. Ellerſhaw, of Chappledale, near Ingleton, deſtroys the moſs by floating in the ſpring ſeaſon.

IRRIGATION IN LANCASHIRE.

Mr. W. Vaughan, of Dunſter Court, to whoſe unceaſing attentions I am inexpreſſibly indebted, has favored me with the papers communicated to the Board of Agriculture by Mr. Holt and others from the county of Lancaſter: from theſe I learn that irrigation is yet in its infancy in that county, although there are a few intereſting inſtances which deſerve notice, and which I am perſuaded, from my perſonal knowledge of that county, may be repeated with a very happy effect.

*It is diſcovered there, by experience, that waters ſtrongly impregnated with metallic or other noxious matter, is improper for the purpoſes of irrigation in the field of agriculture. Water of any deſcription may nevertheleſs prove uſeful to other ends of this ſcience; and in reſpect to its mechanical application, as a moving power, to machinery, perhaps few counties have received greater benefit than that of Lancaſter. Streams of water, which have paſſed unheeded by

* Agricultural View of Lancaſhire, p. 141.

for ages, are ſaid, within a few years paſt, to have proved of more real value to their preſent poſſeſſors, than the real eſtates have been worth otherwiſe to their ſeveral proprietors.

How eaſy would it be for thoſe who have a competent knowledge of hydraulic engineering to convert the numerous little ſtreams of this hilly country to innumerable advantages in agriculture and domeſtic economy. In this ardent wiſh, however, if I may be permitted to indulge an anxious hope for its completion, I would be nevertheleſs underſtood to apply irrigation to arable lands; and to be always mindful of the culture of corn, let what may be the gain by grazing.

I find a note or two in this authority, which merit particular notice in regard to the lights they afford on the value of water, even in its neceſſary application to culinary uſes. We are told that a freehold in this county has continued for three generations in the poſſeſſion of a certain family, who (loth, I ſuppoſe, to think themſelves wiſer than their forefathers) have continued in the plain beaten prejudice of carrying a ſupply upon the head in a pail, from a ſtagnant pool at a conſiderable diſtance. The preſent poſſeſſor,

poſſeſſor, it ſeems, purſued the accuſtomed track of the family for about fifteen years; but, in the year 1794, took courage enough to commence the tremendous operation of digging a well: this, within ſix feet of his kitchen door, produced a conſtant ſupply of fine ſpring water, at the very ſerious expence of ſeven ſhillings and ſixpence.

A ſimilar waſte of labour is frequently to be obſerved in driving cattle to a diſtant watering place, when a very ſmall proportion of that labour would bring the water to the farm-yard, and appropriate the ſaving to a more uſeful employment in huſbandry.

There are two examples near Garſtang, in this county, which, from the mention made of them in theſe papers *, deſerve the attention of thoſe who would profit by a combination of irrigation and drainage. One of theſe is by W. F. Brockholes, Eſq. of Claughton; and the other by Mr. Richard Jones, of Peel, in Little Hulton, near Bolton. But, above all other improvements in irrigation which this county ſeems to boaſt, there is one mentioned as an original, which

* See Lancaſter Survey, p. 102.

ſtrikes

ſtrikes my mind with an idea of ſuperior importance. *Mr. Bootle's game-keeper, at Latham*, has, by means of ditches, collected water to a pool upon the higher grounds; this pool is conſtructed with ſides of pounded clay, and the water, in its paſſage to it, paſt the farm-yard and houſes, brings all the fructifying particles with which they are enriched. In this reſervoir the water is retained till wanted in dry ſeaſons, or for other partial applications; and, in the principal channels of diſtribution, he has added marl, through which the water paſſes, and yields thereby an additional fructification.

I confeſs I think the reward given to this game-keeper by the Agricultural Society of Manchester has alſo much merit in it—they preſented the good man with a *ſilver cup*. *I* hold this very far more eſtimable, for its purpoſe, than that flatterer of vanity *a golden medal*. The good wholeſome home-brewed ale, with which it ſmiles at Chriſtmas and harveſt-home, will be much more likely to revive an uſeful converſation, and a prompt diſpenſation of its emulating reſults, than the exhibition of a bauble, whereof

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the recollection vaniſhes with the novelty, and whoſe only remaining worth can be eſtimated by the jeweller.

IRRIGATION IN CHESHIRE.

The practice of irrigation by Mr. Fenna*, of Baddly, near Namptwhich, in Cheſhire, is very ſimilar to the method uſed by the German ſettlers in America, in the irrigation of meadows with liquid manure.

The farm-houſe and yard are ſituated upon a ſtratum of clay and marl to a conſiderable depth, and therefore the water, in rainy ſeaſons, is not much decreaſed by abſorption. The ſap from the dunghills, and moiſture from the cowhouſes, &c. is collected into reſervoirs. The moiſture from the waſhhouſe, ſtables, pigſties, neceſſary, &c. which only runs during rain, and a few hours after, is diſtributed into the firſt field by a gutter called the *firſt level*. This farmhouſe is ſaid to be unfortunately ſituated upon the higheſt ground, with a declivity

* See Communications to the Board of Agriculture, Vol. II. p. 334.

from

from it in all directions, which prevents any additional water being brought to it by collecting gutters; and therefore the whole quantity here uſed is what falls from the clouds upon the buildings, yard, &c. being about two acres of ground; and yet this, inconſiderable as it is, promiſes to be ſufficient for the maintenance and improvement of about eight acres of land for mowing or paſture. The waſh from the yard, previous to its being uſed for floating, proceeds, by means of carriage-cutters, to the lands to be irrigated. It is thence diſtributed into ſucceſſive zig-zag trenches, which are carried acroſs the lands which the line of level purſues. This form of trenching is adopted in order to keep an equal level acroſs the ridges and furrows, which the former ſtate of conſtant ploughing has left irregular on the ſides or ſlopes of the declivities, ſo that the trenches may be of no greater depths or dimenſions in the ridges than in the adjacent furrows, or what, in Cheſhire, are called *reans*; and that each level may, when charged with water, diſcharge it equally over the loweſt edge of the trench, from one end to the other at one and the ſame time.

The

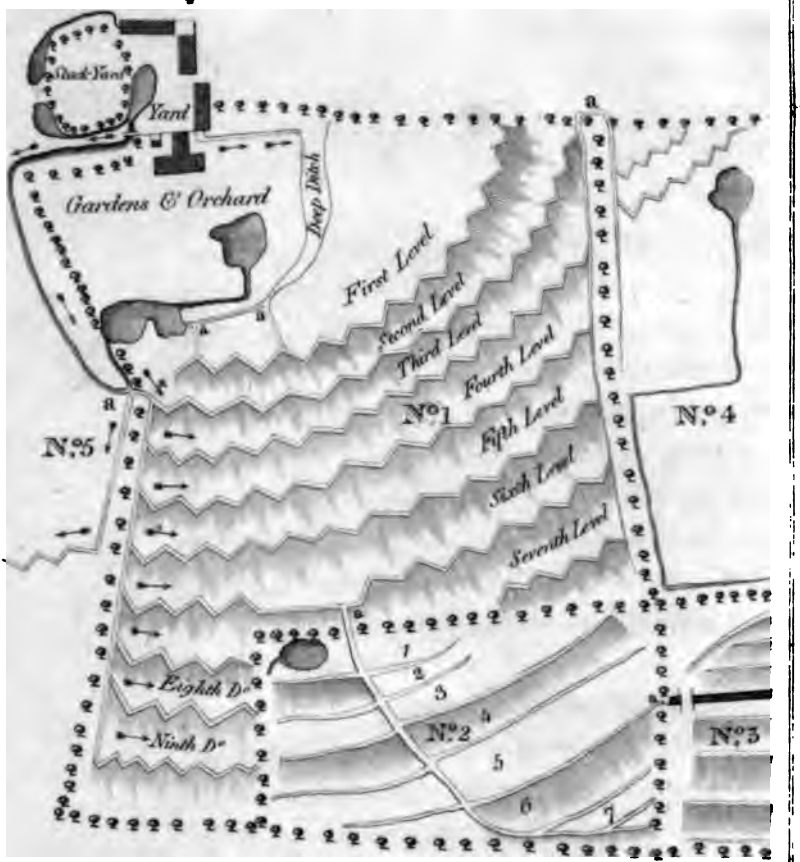
The gutters which are cut in this firſt field are, at the end where they receive the water from the carriage-gutter, eight inches wide at the top, and ſix inches deep, ſharp at the bottom, or of no breadth, commonly called a prickt-gutter, gradually tapering to the extremity, where it is no more than four inches wide, and four inches deep; they are cut acroſs the declivity of the field, at the diſtance of ten or fifteen yards from each other. The ſod, taken from a gutter of this ſort, is priſmatic or wedge-like; and one of the largeſt, at the end adjoining the carriage-gutter, is retained and uſed for a ſtop, and placed either in the collateral level, or the carriage gutter, as occaſion may require; the others have here been chopped to pieces, and ſpread in the furrows or *reans*, in order in time to make the field more upon a level. Where not wanted to level hollow or low places, they ſhould be carried into heaps and mixed with dung for a compoſt. There is no part of any gutter raiſed by the ſtuff taken out, and therefore the mower meets no more obſtruction than he did previous to their being cut.

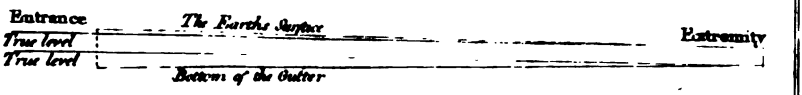
Method

Method of floating the fields.

When it rains, the reſervoirs are pounded up as high as they can be, without injury to the yard, whilſt the rains from the other ſide of the buildings, including the waſh from the waſhhouſe, pigſties, neceſſaries, &c. are collected into one gutter, or deep ditch, and turned into the firſt level by the ſtop; which level becomes thus filled from end to end, and flows down the declivity of the field: but the tendency the water has to quit the ridges, makes it neceſſary to cut a ſmall channel in each ridge, two inches wide and two inches deep.

After paſſing over the ſlope, or part immediately below the firſt level, it is again collected by the ſecond level, and diſperſed over its flat; and in the ſame manner over the third, fourth, fifth, and ſixth levels. But when the water is wanted for another meadow, one of the levels, ſuitable thereto, becomes a collecting gutter, and by a proper removal and management of the ſtops, its contents





J. Pinkin sculp. 58 Drury Lane

contents are poured through the gateways a a a a, into the field for which they are demanded.

Thus each level and field is alternately managed as occaſion requires; and, one or two days after the rain ſhall have ceaſed or abated, when the ſurface of the field appears dry, the reſervoirs of black thick water are let out and diſtributed where they are needed moſt. The reaſon why theſe were not let out ſooner was, the quantity of rain happening to fall might, perhaps, have carried it off over the ground; and the reaſon why it ſhould not be uſed later, or in dry weather, is, the ground is then open and porus, and the reſervoirs do not hold a ſufficient quantity to reach far upon the field.

Thus it appears that a due obſervance of the declivity and points of diſtribution, will render the ſame gutters and trenches, duly managed by the ſtops, alternately works of irrigation and drainage; and, a ſimilar attention to the ſtops, will either diſtribute the water through the ſucceſſive levels, or partially to any which you would uſe for irrigating by the continuance of the carrier-trench, and turning off the needleſs levels of the time.

The

The declivity allowed to theſe levels is an inch to every ten rood: this is ſufficient to carry forward the water through its various operations. Hence you may either flow the whole levels and fields in ſucceſſion, or you may flow the fields in rotation, according to the number of them which are connected with your works.

In other fields, on the eſtate of Mr. Fenna, we find he contrives to collect water in the time of rains, from all the grounds which lay upon a higher level than thoſe which he deſigns to irrigate. This method ſhould indeed be obſerved in all caſes of irrigation; for by means of ſuitable catch water-drains along the ſides of more elevated lands, leading to reſervoirs dug on eligible ſcites, it is very practicable to irrigate lands, either with ſimple or compound liquid, although there be not any other water to reſort to than that which falls from the heavens.

Gentlemen who wiſh to purſue this method of irrigation, with minute attention to the ſyſtem practiſed by Mr. Fenna, will do well to refer to this gentleman's detail deſcription, as communicated to the Board of Agriculture. It is to be lamented that we

are

are not fully favoured with thoſe reſults of his crops which authoriſe computation. I have endeavoured to give his principles ſuccinctly, but ſufficiently to authoriſe an imitation, which will neceſſarily vary according to the circumſtances connected—and genius muſt be greatly relied on. I take the liberty of recommending, however, the employment of an engineer, who has made theſe points his ſtudy; and I have no heſitation in foretelling, that the reſult will return an ample compenſation for the aid of profeſſional ſkill.

IRRIGATION IN GLOUCESTERSHIRE.

In 1789, the Reverend Mr. Wright publiſhed a ſmall, but valuable pamphlet, on the art of watering meadows, as it is practiſed in Glouceſterſhire. This was printed at Cirenceſter, and as I have been fortunate enough to procure a copy of it before I cloſe my work on this very intereſting topic, I will endeavour to diſtribute the principal points of his communication to the farther advantages of agriculture.

In the preface of this useful little work, the author, very properly, goes into a previous explanation of the terms of art which are applied to describe this science in Gloucestershire; for it is to be lamented, that terms of art, as well as provincial phraseology, are not yet reduced to any uniform standard within the sphere of a modern dictionary.

The *works* (says he) are the large ditches, by which the water is introduced into the meadow.

The *trough* is a smaller ditch, which branches from the works.

The *stop* consists of one, two, or more stakes, driven down in the middle of the works and troughs, to obstruct the course of the water, and to keep it high enough to flow through the sluices.

The *sluice* is a small apperture made in the sides or banks of the works and troughs, at the distance of one or two yards, and through which the water passes that covers the surface of the land.

The *drains* are ditches cut in various directions, and different dimensions, resembling the branches of a tree, and all terminate

minate in one large trunk, which carries the water back into the ſtream.

The advantages (ſays he) ariſing from this mode of watering are many and great. If it be well executed, I may freely venture to aſſert, that this mode of cultivation will be found more productive than any modern improvement in agriculture. By it land, whatever its kind or quality, is increaſed to *double* or *treble* its former value. And it does not derive this enriching power from the aſſiſtance or ſpoil of the neighbouring lands, but it diffuſes a general fertility. It does not rob the farm-yard of its ſtores, nor even take back from the abundance which it there produces; for it ſtands in need of no dung, no expenſive preparation of manure or compoſt. So that the farmer, who occupies fifty acres of this watered land, has an hundred tons of hay to carry off and ſpend upon his other grounds. But it is not merely the crop which conſtitutes the excellence of watering; it is the *earlineſs* and *certainty* of the crop.

Every intelligent farmer is ſenſible of the great value of graſs very early in the ſpring; and we, by watering, have plenty of graſs at the beginning of March, and when the

ſeaſon is mild, ſomewhat earlier. The good effect this graſs has upon cattle that have been unhealthy or hard-wintered, is aſtoniſhing. The ſecond week after turning into the meadows, a very viſible change is made in all cows, horſes, and ſheep: and the farmers are here enabled to begin cheeſe-making at leaſt a month ſooner than their neighbours, who enjoy not the benefit of watering their land. And in fatting of lambs, the value of graſs is ineſtimable.

With regard to the certainty of a crop I need not ſay much; the thing will ſpeak for itſelf. Between March and May we are ſure of ſpring-feed that is worth, at leaſt, a guinea per acre; in June we have a crop of graſs that will yield two tons of hay per acre; and the latter-math is always worth a pound. Let the ſummer be ever ſo dry, we have nearly the ſame quantity. After the laſt dry ſummer, the advantage of watering was evident; for the neighbouring farmers were obliged to come hither to buy hay, at whatſoever price the owners thought proper to demand.

Other advantages of watering there are which ought not to be paſſed over unnoticed. The land thus treated is continually improving;

proving; its herbage, if coarſe, is fined; its ſoil, if ſwampy, becomes ſound; and an addition is made annually both to the depth and quality of its mould.

As a kind of proof of ſome of the above aſſertions, I ſhall thus inſtance the product of one of our meadows this preſent year. It is one that has been watered longer than the memory of the oldeſt man in the pariſh; but it is by no means the beſt meadow upon the ſtream, nor has this year been a favourable one for watering. It is about ſix acres and a half. The ſpring-feed of it was let for ſeven guineas, and well ſupported an almoſt incredible number of ſheep (an hundred and fifty), for two months; the hay was ſold for thirty-two guineas; and the latter-math for ſix.

Mr. Wright then proceeds to a preference to muddy or ſaturated water, which Mr. Boſwell, I find, conteſts in favour of *limpid* water: poſſibly both may be right under a difference of circumſtances. I ſhall therefore paſs over this particular, referring thoſe to a compariſon of their reaſonings who may wiſh *chemical* ſatisfaction on this head; it appears pretty clearly, I think, that the practical facts are good in both inſtances

and practical experiments will be the beſt guides on every variety of ſoil and ſituation.

Mr. Wright ſtates the quantity of land irrigated in his pariſh to be three hundred acres; and the ſtream, from whence the water is drawn, to be moſtly equal to a ſection of five yards by one—but ſeldom to exceed ſuch dimenſions.

The three following things, this gentleman tells us, are neceſſary to be conſidered:

1. "Will your ſtream of water admit of a *temporary** wear or dam acroſs it?"

2. "Can you dam up and raiſe the water higher than any part of your meadow, without flooding and injuring your neighbour's land?"

3. "Can you take the water off your meadow as quick as it is brought on?" And he might have added, in regard to the preſent improved knowledge of mechanical powers,

4. Can you apply machinery, moved by wind, by water, by ſteam, or by animal

* Mr. Boſwell, in his Treatiſe on Water-Meadows, p. 116, objects to TEMPORARY wears; for reaſons which appear to have ſome weight in reſpect to ſubſequent injuries from their remains. Much in this caſe, I think, may depend on the quality of the ſoil and wear.

labour,

labour, as the power of motion, to convey water over your land, at an expence which will bear a light proportion in the ſcale of preponderating profit?

If you can anſwer ſuch of theſe queſtions in the affirmative as apply to your particular caſe, I have no heſitation in ſaying you ought to proceed immediately to erecting works for agricultural irrigation; and if you do not do it, you will repent every year's neglect.

In this caſe, if you prefer the Glouceſterſhire method, you will conduct the water along the higheſt part of your meadow, by means of a deep wide ditch, ſuch as they term the *maſter-work*, the banks whereof ſhould be of an equal height, and a few inches higher than the general ſurface of the meadow. In large meadows, ſuch works muſt be repeated according to the diviſions of the ground. Theſe ditches ſhould be about nine feet wide, and a proportionate depth, to a plat of about fifteen acres. And theſe works are ſometimes repeated in number, ſo as to give ſucceſſive waterings to larger tracts.

Smaller *ditches* or *troughs* are to be cut from theſe, at nearly right angles, and their

reſpective widths to be, of courſe, proportioned to the diſtance they are to be carried, and the demand of the part to be irrigated.

The diſtance of theſe ditches from each other ſhould be about ten or twelve yards. Ten yards wide upon the ſurface may be watered by a ditch of two feet wide, and one deep. Mr. Wright limits theſe kind of troughs to forty yards long; but, if the ſupply of water is ſufficient, I ſee no difference between the diſtance of forty yards and forty miles, where repeated communications can be made with the work. In each of theſe troughs frequent ſtops are to be placed, eſpecially where the water is rapid, in order to keep it high enough to flow through the ſluices, or over the ſides.

It is obvious that the works and ditches, or troughs, may be diminiſhed in their progreſs downwards; for this operation, which diſtributes water to a thirſty ſoil, which retains a proportion as it paſſes, is evidently the reverſe of the operation of drainage, which draws off the ſuperabundant ſupply of moiſture, in a ſtate of continual accumulation; and requiring a wider ſewer in its progreſs towards the ſea, upon preciſely the ſame principles of ramification which nature has

has employed in the formation of rivers. Wherever the water ſeems inclined to ſtand, a drain or narrow ditch is to be immediately cut into the main drain which carries off the water.

In cold flat, ſwampy meadows, Mr. Wright ſays that the diſtance between trough and drain ought never to exceed four or five yards. The fall of the ground he alſo regulates at half an inch per foot for meadows. He ſays the water ſhould never flow more than two inches deep over the land. When the graſs is two inches high, he is of opinion the water ſhould never ſhew itſelf, except in the ditches. I apprehend, however, that in very thirſty lands or warmer climates, it will be better to reſort to a little local experience, than to confine the operation to the obſtinate rule of a limited ſpot. In this reſpect, when Gentlemen think proper either to ſend their own farmers to learn the art in an irrigated country, or to employ a profeſſional irrigator from thence, I would recommend the addition of their own judgment on the principles of natural philoſophy. In hot countries I have had ſufficient experience to convince me, that few graſſes will

will ſtand watering under the immediate influence of the ſun; but if you ſuffer the ſun to go down, and avail yourſelf of that moment to irrigate your lands with an hour or two's flow of water, taking care to turn it off at the expiration of that time, you may ſafely, I think, uſe this mode of irrigating graſs, and perhaps grain, throughout the earlier ſtages of vegetation, until it appears to be time to let the natural proceſs of ripening commence. A method of this kind will furniſh a pearly dew every morning through the heat of the ſummer; and I take that to be a degree of moiſture which is the moſt agreeable to the natural requiſitions of the vegetative principle.

Sometimes, Mr. Wright tells us, it is neceſſary to carry the drains under the works and troughs, in order to get rid of the ſurplus water after it is uſed. In this caſe, it is the practice in Glouceſterſhire to make uſe of boards, and boards and planks, for conveying the water above in the manner of an aqueduct over a river; and this is here termed a carry. For the better regulating the diſtribution of the water in ſpring, it is alſo cuſtomary to dig ſmall temporary trenches where

where they ſeem to be moſt wanted, laying the ſod or mould by the ſide of them, that it may be replaced when the watering is over. In replacing this ſod, the irrigation ſhould always look forward to the ſcythe, ſo that this may not prove a future obſtruction to mowing.

Mr. Wright ſpeaks of grounds which have been ploughed into broad lands and furrows as the beſt ſhape for irrigation; becauſe ſuch ſhape admits of conveying the water quickly along a ſmall ditch upon the ridge, and paſſing it off by the furrow.

Every meadow ſhould therefore be brought into this ſhape, according to his recommendation; though it is ſometimes neceſſary to make three works, one acroſs each end of the land, and one diagonally. It is clear to me, however, that genius and experience muſt be employed in this reſpect, according to the nature of each particular caſe.

When the lands are thus prepared for irrigation, the Glouceſterſhire method of applying the water is as follows: in the beginning of November they cleanſe all the works, troughs, and drains from graſs, weeds, and other impediments; and repair the banks, if they are injured by the feet of cattle or other caſualty.

caſualty. The opportunity of the firſt ſhower is then ſeized on, for the purpoſe of irrigating with as much muddy water as poſſible; the richneſs and ſalts, which the waters are ſuppoſed to contain in greater abundance at this ſeaſon, are thus depoſited as a manure to the impoveriſhed ſoil, and the water taken off in about three weeks.

The Author of a late Hiſtory of Cirenceſter, who has followed a later edition of Mr. Wright's pamphlet than I have ſeen, ſays, that in December and January care is to be taken that the land be ſheltered by the water from the ſeverity of froſty nights. But it is neceſſary through the winter, every ten days or fortnight, to give the land air for a few days, by taking the water entirely off, otherwiſe it would rot the roots of the graſs. And every meadow ſhould be ſurveyed twice a week, to ſee that the water is equally diſtributed, and to remove hurtful obſtructions from ſticks and weeds.

In February much caution is neceſſary, if the water remain on the meadow for many days without intermiſſion, as it will generate a white ſcum, very deſtructive to the graſs. On the other hand, if it be taken off, and the land expoſed to a ſevere froſty night, without

without being previouſly dried for a whole day, it will cut off much of the tender graſs. To avoid theſe injuries, take the water off by day, to prevent the ſcum, and turn it over at night, to guard againſt the froſt; or both may be avoided, by taking the water off entirely for a few days and nights, provided the day on which it is taken off be dry; for after one fine drying day, a froſt at night will do the graſs little or no injury. Towards the middle of this month, uſe only about half as much water as in the winter. Rather wet than water; for at this ſeaſon it is only neceſſary to keep the land in a warm humid ſtate, to force vegetation.

At the beginning of March there is generally on ſuch meadows abundant paſturage for all kinds of ſtock. But the water ſhould be taken off for nearly a week before heavy cattle are turned on; and if the ſeaſon be cold, it is proper, during the firſt week, to give the ſtock a little hay at night.

Some perſons eat off the ſpring feed with ewes and lambs, by encloſing them with flakes or hurdles in a certain portion of it every day, giving hay at the ſame time. This is certainly making the moſt of the graſs, and an excellent method to fine and ſweeten

ſweeten the future herbage. In March and April the graſs may be eaten as ſhort and cloſe as poſſible, but never later. If the month of May be treſpaſſed on for only a week, it will very materially impair the hay crop; the graſs will be ſoft and woolly, like latter-math.

When ſpring feeding is finiſhed, the water is again neceſſary for a few days by way of wetting.

It is remarkable, that watering in autumn, winter, and ſpring, will not occaſion the rot in ſheep; but has been known to remove the cauſe from meadows which had rotted. But if the water be uſed, though only for a few days, in any of the ſummer months, the paſturage will be unſafe for ſheep. Take one inſtance: at the beginning of July, the hay being off, and the river very muddy from abundant rain, the water was thrown over a meadow for ten days; in about a month the ground was covered with an uncommon luxuriance of herbage, into which eight ſound young ewes, and two lambs, were turned to depaſture: the lambs were killed ſix weeks afterwards, and had ſymptoms of rottenneſs; and in about a month or ſix weeks more, the ewes were alſo killed,

and

and though they were very fat, their livers were putrid, and replete with the inſect called the fluke, or weevil. This experiment aſcertains the event, and, at the ſame time, proves that muddy water in the ſummer is much richer than in the winter or autumn, and may be very advantageouſly uſed, for a week at leaſt, every wet ſummer, notwithſtanding the inconvenience as to ſheep.

All objections to watering meadows after this method, ſuch as cutting the ground, laying out meadow, and other expences; that hay thus produced is inferior to upland hay, &c. are abundantly countervailed by the advantages. The coarſeneſs of the hay is obviated by cutting early, when it will be excellent: but thoſe who are covetous of having nearly three tons to the acre, muſt be content with long, coarſe hay.

The advantages are, the land and herbage are continually improving, without manure; the crop is not only full and certain, but it is alſo early. And who is not ſenſible of the aſtoniſhing effects of early graſs on all ſorts of cattle, but particularly ſheep and lambs?

With

With theſe advantages, it is ſurpriſing that the practice has not long ſince become general throughout the kingdom. In this neighbourhood the moſt inſignificant ſpring or rivulet is not ſuffered to paſs unreſtrained; and whenever a ſudden ſhower occaſions a temporary flood, proper ditches are made to receive the water, and to ſpread it equally over the land; but there is no ſtream or river on which a mill is or can be erected, but what may be made very enriching to a certain quantity, if not a large tract, of land.

In levelling a work for irrigation, care ſhould be taken to proportion the current to the diſtance: for example, if the diſtance is one hundred yards, and the fall four inches, then it is one inch fall to each twenty-five yards, and ſo in proportion.

Expla-

PLATE 1

Explanation of the annexed Plates, from the Hiſtory of Cirenceſter.

PLATE I.

Repreſents a meadow regular in its ſurface with the current of the river, but too high to be floated from the part of the ſtream immediately oppoſite to it. In order, therefore, to gain a fall, the water is taken out at a higher part of the ſtream by a conductor, as at C, into the feeder, which is cut along the higheſt part of the meadow, and has a flood hatch in the mouth of it, to admit or exclude the water at pleaſure. This conductor we will ſuppoſe, for the ſake of illuſtration, has only four inches deſcent in its whole length, but the ſtream in the ſame length falls ten inches; therefore, ſix inches of power are gained by means of the conductor, which is a fall abundantly ſufficient for floating the meadow. By this mode of gaining deſcent, thouſands of acres may be floated, which ſome would think impoſſible to be done.

Fig. 1 and 2 repreſent a tranſverſe ſection of two ridges, with their ſides or beds an inlined plane. The floating gutters, or troughs, as we ſometimes call them, (marked F. G.) are drawn with double lines; and the ſtops in theſe and the feeder are marked with ſmall circles and the letter S. The drain cuts are made with ſingle lines.

PLATE II.

Repreſents a floated meadow, which had three parts conſiderably higher than the general ſurface of the land. In order to throw the water over the higher parts, it was neceſſary that each ſhould be accommodated with a ſeparate feeder, as ſhewn in F. 1, F. 2, F. 3, with its ſtops, gutters, notches, and drains. In this method the floating may be alternate through the winter.

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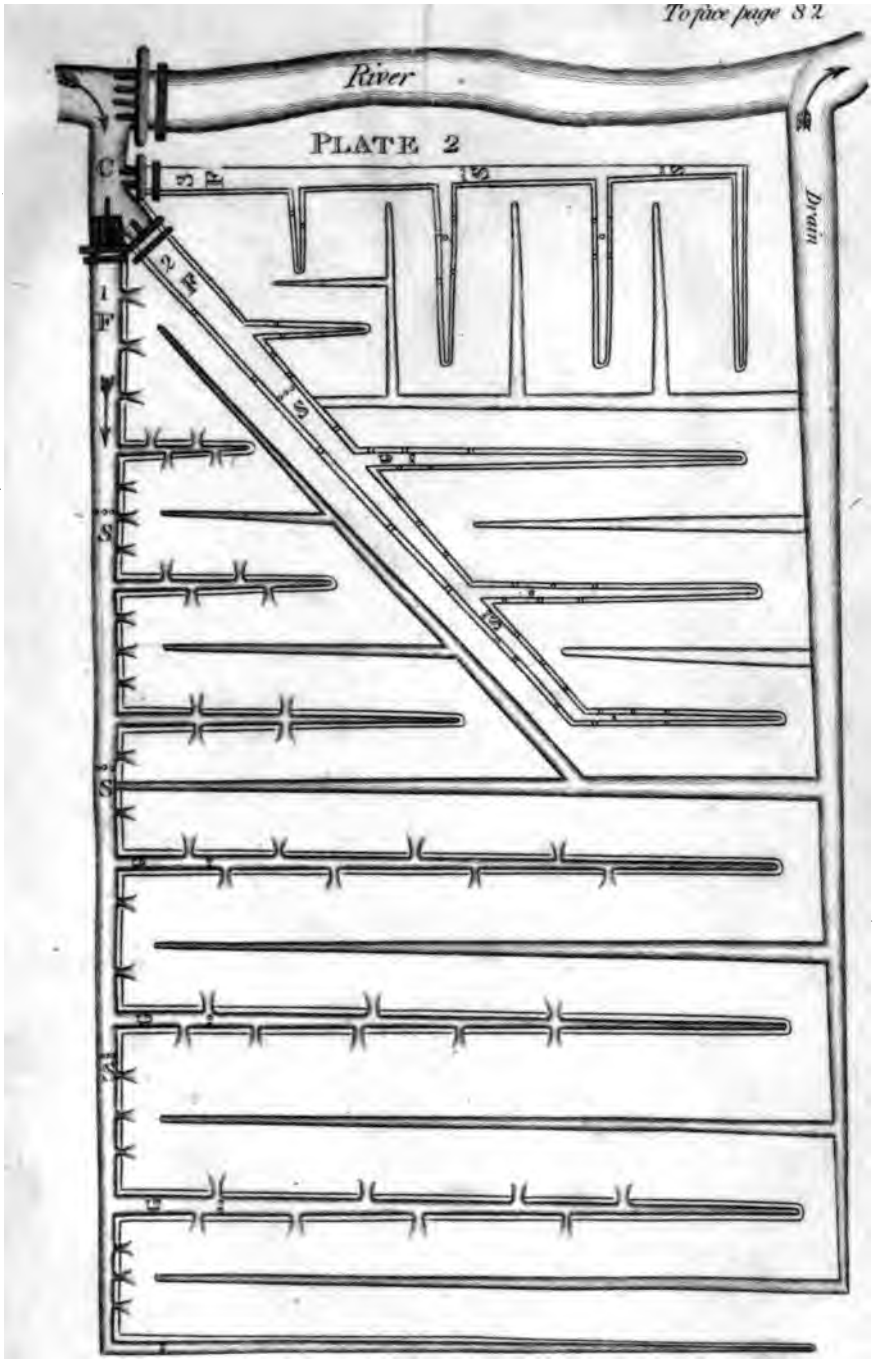

Girtin sculp.

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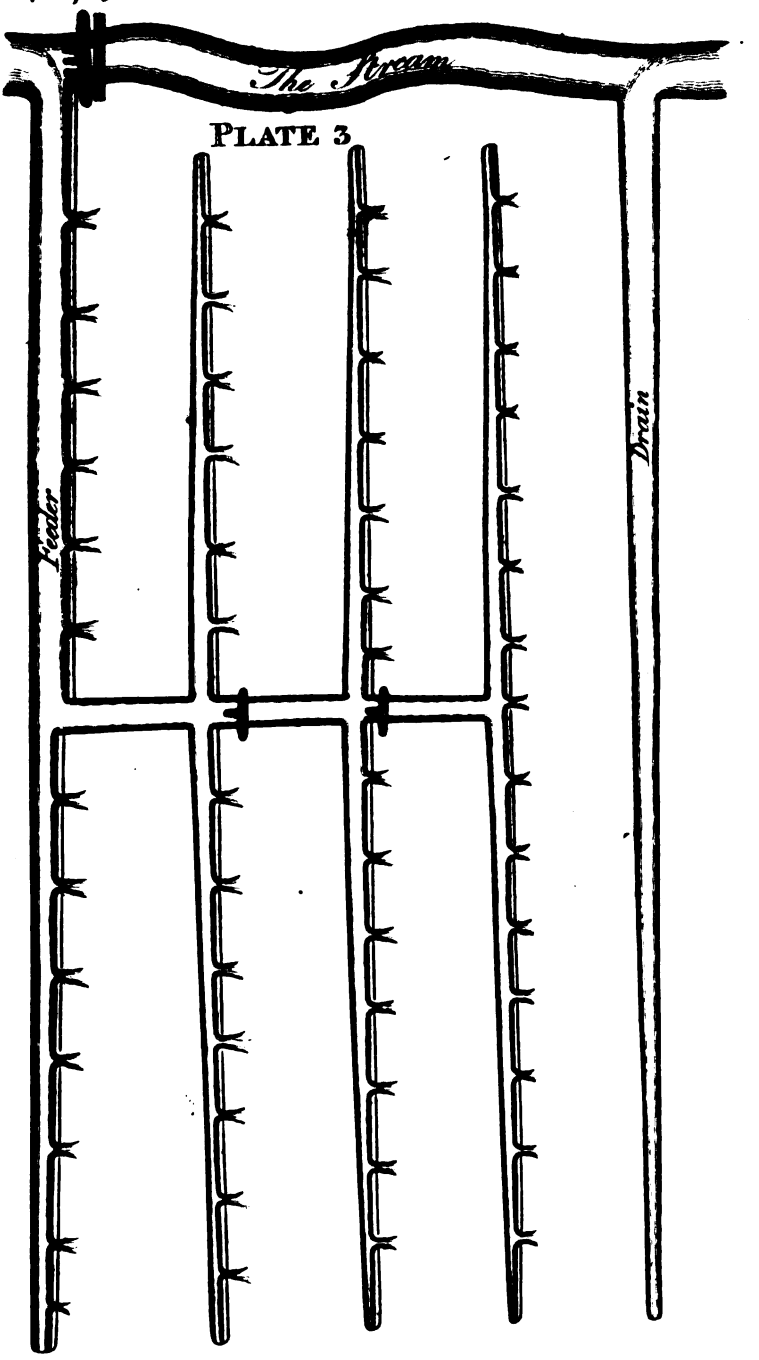

PLATE III.

Repreſents a ſort of floating commonly called *catch-work*, where the ditches are made at a diſtance below each other, acroſs the declivity, to catch the water, again and again, from the top to the bottom of the meadow. It is evident that the upper beds muſt receive more than their ſhare of the nutriment that is depoſited. This method ſhould never be uſed but where the declivity is too great to admit the floating gutters to point down the deſcent, as in the other method.

In December and January, ſays Mr. Wright, they are careful to ſhelter the lands from froſty nights, by keeping the water flowed over it. In February they enjoin a more particular care not to let the water remain many days, on account of a white ſcum which ariſes, and is very injurious to the graſs; and the danger of killing the graſs by the froſt at this ſeaſon.

The only way to avoid both theſe riſques, Mr. Wright ſays, is to take the water off in the day, and turn it on at night; for it is only when the graſs is wet, that the froſt is ſo pernicious.

Mr. Boſwell, on the contrary, condemns this doctrine, and ſays, that although the warmth of the ſun is ſeldom ſufficient to have an effect upon the water in the month of February, that it is not uncommon in that month to have the waters kept upon the meadows for a fortnight or more; and that as the froſt ſometimes freezes up the hatches or flood-gates in one night, meadows are covered for ſeveral weeks with ice; and that when the froſt is gone off, thoſe meadows always ſhew the fineſt verdure ſooner. I incline

incline to coincide with Mr. Boſwell on what I have remarked in regard to a crop of wheat being covered with ſnow, as a ſhelter againſt the chilling blaſt; and for ſome other reaſons which are better explained in my two papers, publiſhed in the two Numbers of the Monthly Magazine, for the months of February and March laſt, on the cauſes which affect the climate of North America: yet I am loth to diſtruſt Mr. Wright's obſervations, and am rather diſpoſed to believe that there is ſome overſight in the buſineſs, or ſome unobſerved principle or other which might reconcile their ſeeming contradictions.

Mr. Wright ſeems to think, that as much water as will cover the ſurface barely, is ſufficient at this ſeaſon. Mr. Boſwell thinks otherwiſe. At the beginning of May, juſt after the ſpring feed is eaten down, the meadows are to be irrigated; and the ſame ſhould be done after taking off the hay. I myſelf have a tract of land in the Tennaſſee country in N. America, upon which I reſided during the hard winter, 1779-80. On this tract was a ſmall piece of upland meadow, of the kind of graſs known in America by the name of *Timothy*, but the Engliſh name of

which is unknown to me*. The ſnow was at this time and place nearly ten inches deep; and ſo frozen, for nearly ten weeks without intermiſſion, that the waters were cloſed up, ſo as to produce an amazing deſtruction of outlying cattle and horſes; the deer and other game ſuffered almoſt an extirpation in many of the neareſt hunting grounds; and, without exaggeration, the wild turkies were ſo tamed from the trees, as to feed among the poultry at the cottage doors. Even this ſevere froſt had no effect on the Timothy graſs; or, at moſt, a very partial one; and the herbage of the meadow made an early and luxuriant appearance on the approach of ſpring.

I have not been able to come at Mr. Blythe's work, the *Improver improved*, of which Mr. Boſwell ſpeaks highly, as a uſeful book on Agriculture, and in reſpect to its general information on the ſubject of irrigation. But I ſhall endeavour to draw from the latter ſome of thoſe uſeful lights which may be reaſonably expected from ſo able a practical farmer.

* Since writing this, I obſerve Mr. Strickland ſuppoſes it to be the *phleum pratenſi* of Withering, variety *nodoſum*.

This

This gentleman adopts Mr. Kent's maxim, in which all the practical farmers we meet with ſeem to concur; and many of them adduce the moſt ſatisfactory proofs of its ſolidity*. "*Flooding is truly the beſt of all improvements, where it can be effected; and there ought not to be a ſingle acre of land neglected which is capable of it.*"

Mr. Boſwell, ſpeaking of the kind of lands which are *capable of being watered*, goes into qualities of the ſoil, and circumſtances which ſeem proper ſubjects of information to practical irrigators, who ſhould endeavour to know every thing. In regard to the proportion of lands which may be watered, he ſeems to confine himſelf to thoſe principally which come either under the level of nature, or require very little aſſiſtance of art. But as my idea of adopting *national machinery*, is competent to humble the mountain top to the offices of aration, I ſhall paſs this part over.

It ſeems proper to take notice of the various implements of irrigation which are uſed in Dorſetſhire, according to Mr. Boſ-

* Kent's Hints to the Landed Intereſt.

well's

well's method of watering. He enumerates the water-level; the line-reel, and breaſt-plough; ſpades, peculiarly adapted to irrigation; the creſcent; wheel-barrows; hand-barrows; three-wheeled carts; ſcythes; forks; long-tined crooks; ſtout large water-boots. I ſhall venture to give his explanation of ſuch as are out of the courſe of ordinary obſervation; uſing my own remarks where I think an advantage may not have occurred to him.

Water-levels.

As the ſcience of levelling is reduced to mathematical nicety, and a great variety of inſtruments are now in uſe among profeſſional engineers, ſuch as every gentleman ſhould employ where he means to render his works permanent and effective, I ſhall only notice ſuch rules of conducting the levels of irrigation as are commonly obſerved by the workmen. The workmen, Mr. Boſwell* ſays, diſpenſe with the uſe of the inſtrument,

* Boſwell on Water Meadows, p. 16.

bringing

bringing the water after them to work by. In drawing *a main*, they begin at the head, and work deep enough for the water to follow them. In drawing a *tail drain*, they begin at the lower end of it, and work upwards, to let the *tail-water* come after them. —This method obtains the exacteſt level.

The line, rule, and breaſt-plough.

I ſhall ſay nothing of the two firſt, which are known to every body. The breaſt-plough is an implement uſed in the agricultural office of *burn-beating*, or *denſhiring*. It is formed ſomewhat in the manner of a ſpade, with broad wings ſuitable, to take a good width of ſod or ſwarth; for the getting whereof it is much uſed in the County of Lancaſter, and other turf countries. It is fixed upon a long handle or helve, with a croſs handle and breaſt-piece to reſt againſt the breaſt of the man, who uſes it by puſhing it forward before him. By giving the blade of the ſpade a ſuitable ſhape, it may be alſo uſed to advantage in clearing out the bottom of drains, ditches, &c. There is a ſimilar

ſimilar implement uſed, in Lancaſhire, in a different way, by puſhing it with the thigh, againſt which a large wooden head or button is ſo contrived as to reſt.

Spades.

The ſtems of ſpades for irrigation are conſiderably more crooked than other ſpades; ſo that the workman, in the bottom of the ditch, may be able to make his drain or trench ſmooth and even, when ſtanding in a working poſition. The bit is made of iron, about a foot wide in the middle, terminating in a point, having a thick ridge down the middle, and thin and ſharp on the edges: when worn thin and narrow, theſe are uſed for the ſmaller trenches, and others are replaced for the larger.

Creſcent.

This inſtrument is made like a gardener's edging knife, but larger, in the form of a creſcent, very thin and well ſteeled, having a ſtem

a ſtem about three feet long, with a croſs-handle to bear upon. Its uſe is to trace out the ſides of the mains, trenches, drains, &c. which, Mr. Boſwell ſays, it does very expeditiouſly, and with eaſe to the workmen, where the land is free from ſtones.

Wheel-barrows.

Thoſe for this uſe are made *open*, without ſides or hinder part. They are principally for conveying ſods, &c.; for embanking, damming, &c.

Hand-barrows.

Where the ground is ſoft and flooded, it becomes neceſſary to ſubſtitute theſe in lieu of wheel-barrows, for conveying clods of earth, &c.

Three-

Three-wheeled Carts.

Theſe appear to be in uſe in Dorſet; and I preſume with a broad tread or tire. Their utility in water-meadows is obvious; as the wheels do not follow each other in the track, and as a proportion of the weight is borne upon each wheel in a triangular form, which will be leſs ſubject to cut and ſink into the ſoil.

Scythes.

Both ſhort and narrow ſcythes are implements of frequent uſe during the running of the water: they are then uſed to take away the weeds and ſuperfluous graſs.

Forks and Crooks.

Theſe are conſtantly wanted during the times when it is neceſſary to clear the drains of weeds and roots. The crooks are formed with

with long tines for this purpoſe, ſimilar to a dung-dragg. Theſe ſhould be made light and with long ſtems, ſo that the workmen can reach into deep water with them, to clear the ſtream from obſtructions.

Stout large-topped Boots.

The tops of theſe ſhould draw halfway up the thigh or better; they ſhould be ſtout leather, well greaſed with tallow, ſo as to reſiſt running water for ten or twelve hours together; and ſhould be large enough to admit of ſtuffing them down with hay all round the legs. The watermen's boots uſed in the New England and Newfoundland fiſheries, would apply well in this caſe. There are ſeveral other implements that Mr. Boſwell has not noticed, which appear to me to apply well to the management of water-meadows, where there are hedges, woody countries, briars, &c. — Such, for inſtance, as *ſprouting-hoes*, *weeding-hoes*, *briar-hooks*, *mole-rakes*, *dock-crows*, *gripes for drawing weeds*, *horſe-ſleighs*, *turf-ſpades*, &c. which, I think, will often be found

found uſeful during the ſeaſon for irrigation.

There are a few technical terms applied to this, as to moſt other ſciences, to which it ſeems neceſſary to affix certain diſtinct ideas; for although theſe are familiar enough to thoſe who are in the habits of agricultural language, this book may alſo fall into the hands of men to whom ſuch things are entirely new: beſides words are ſometimes adopted technically, which convey a very different idea of the meaning in their unqualified conſtruction; as, for example, the word *regiſter*, when applied to the principal ſafety-valve of an air veſſel or water-main, differs materially from the ſame word denoting a book of records.

The terms explained by Mr. Boſwell, in *his* ſyſtem of irrigation, are, *ware*, *ſluice*, *trunk*, *carriage*, *drain-ſluice*, *hatches*, *head-main*, *ſmall-main*, *trench*, *trench-drain*, *tail-drain*, *pane*, *way-pane*, *bend*, *gutter*, *catch-drain*, *pond*, *turn*, *head of a meadow*, *tail of a meadow*, *upper ſide of a main or trench*, *lower ſide of a main or trench*, *upper pane in a meadow*, &c.

All theſe appear to be ſubjects proper for explanation, that the reader may not be at a

loſs

loſs when they occaſionally occur; and that gentlemen may be better able to apply ſuch improvements to their reſpective ſituations.

* Mr. Boſwell defines a *ware*, to be an erection acroſs a river, brook, rivulet, main, &c.

Sometimes, he ſays, wares are made of timber, ſometimes of brick, ſometimes of ſtones and timber, with from two to eight or ten *thoroughs* (openings), to let the water through, according to the breadth of the ſtream. The height of this ware muſt be regulated by the dimenſions of the ſtream and the level of the adjacent land, as its uſe is to ſtop the whole current, ſo that the water may riſe high enough to overflow the meadow intended to be irrigated; or to convert it to the uſe of ſome diſtant meadow, by thus turning it into mains and ditches.

A *ſluice* differs from a ware, only in reſpect to its having but one thorough; for, if there be more thoroughs, it then becomes a *ware*. It applies to a ſmall ſtream, for the ſame purpoſes which a ware does to a large one.

* Boſwell on Water Meadows, p. 24.

A *trunk*

A *trunk* is literally a covered ſluice, and is ſo conſtructed in all caſes where two ſtreams of water are to croſs each other at the point of diſcharge, or if it is to ſerve as a bridge.

A *carriage* is a ſmall ſpecies of wooden or brick aqueduct, built open, for the purpoſe of carrying one ſtream over another. Mr. Boſwell conſiders this the moſt expenſive conveyance belonging to watering.

A *drain-ſluice*, or *drain-trunk*, ſays Mr. Boſwell, ſhould always be placed in the loweſt part of ſome main, as near to the head as a drain can be found that is ſituated low enough to drain the main, &c. It is placed with its mouth at the bottom of the main, and let down into the bank, and from its other end a drain is cut to communicate with ſome trench-drain that is neareſt. This contrivance is uſed to carry off the leakage through the hatches when they are ſhut down to convey the water to other grounds, or to repair the main, &c.

Hatches ſeem to be literally another name for flood-gates, and applied to the ſame purpoſes; they may, of courſe, be variouſly conſtructed. Mr. Boſwell uſes a particular kind, with about a foot to take off, ſo as

to

to permit the water to flow over that much of the hatch where it appears to be uſeful in irrigation. This method might, I think, be improved by conſtructing the hatches in the manner of the kind of Venetian ſhades which turn upon an axis.

A *head-main* ſignifies that part of the principal ditch which takes the water firſt out of a river or ſtream, for the purpoſe of diſtribution through its ſmaller ramifications.

Small mains are the next gradation of ditches which are applied to diſtribution, by means of their communication between the head-main and trenches. Theſe are, by ſome, confounded with other works, by the term *carriages*.

A *trench* is the laſt diſtribution-ditch in watering, continuing to decreaſe its dimenſions as it ſpreads the water over a greater extent of ground.

A *trench-drain* is a deep ditch or drain which meets the trenches, for the purpoſe of taking the water away ſpeedily after the irrigation is performed. It ſhould be cut parallel to the trench, and as deep as the tail-drain water will permit; if poſſible ſo as to reach the ſtratum of ſand, gravel, or clay—a ſpade's depth into the laſt would be an ad-

vantage. Its gradations are exactly the reverſe of the trenches, which it meets in the manner of two forks, placed with their points into each other at regular diſtances. Its parts, of courſe, increaſe as it receives ſucceſſive ſtreams to be drained off.

A *tail-drain* is the principal ditch which conveys the water out of the meadow. It receives that which all other drains diſcharge, and ſhould conſequently lead to the loweſt poſſible point of diſcharge, and the neareſt direction which the ground, under every circumſtance, will permit. If uſed as a fence-ditch, this anſwers a double purpoſe.

A *pane* of ground ſignifies the part containing the graſs to be mown between the trench and trench-drain: each of ſuch ſtrips of land are called *a pane*.

A *way-pane* is the ſtrip of land left for cartage, along the ſide of the main, being watered from the banks of the main, and drained by a parallel ditch.

A *bend* is defined by Mr. Boſwell to be, a ſtoppage made in various parts of thoſe trenches which have a too quick deſcent, in order to check the water and force it out of the trench. This is done by leaving ſmall dams

dams of the natural ſward at proper places, and cutting a ſod out of them wedgeways; ſo as to limit the impetuoſity of the current and give a more equal diſtribution of the water.

A *gutter* is a ſmall grove cut from the tails of the trenches, occaſionally, to diſtribute the water to the utmoſt extent of the panes more equally than could be effected by the regular works, ſo as by this means to avoid patch-work or omiſſions.

A *catch-drain* is an occaſional ditch which is ſometimes cut to carry the ſame water into a ſecond main, for the purpoſe of irrigating a lower meadow or pane with the ſame water which has been uſed. The watermen conſider it then, however, to be in an impoveriſhed ſtate, on account of the particles juſt depoſited, or communicated to the lands above.

A *pond*, in irrigation, is applied to any ſpot of ſtagnant water, which is left on the ground in the proceſs of irrigation, to the detriment of the crop.

A *turn* of water, ſignifies as much as can be diſtributed at a ſingle operation, by the management of the hatches within reach of

the labourers employed, and as the ſtre m will ſupport.

The *head* of the meadow is that part into which the *main* firſt enters.

The *tail* of the meadow, being the reverſe, is that part where the tail-water laſt paſſes off by the tail-drain into the natural ſewer; or where that ſewer itſelf leaves the meadow.

The *upper* ſide of the meadow, is that which fronts the point at which the main or river entered.

The *lower* ſide is, conſequently the reverſe of the above.

The upper *pane* is that which lays above the main, if ſuch a one be left.

As gentlemen who incline to irrigate their eſtates will, doubtleſs, procure the aid of practical men, and experienced examples as far as poſſible, I ſhall forbear to go into farther detail of the practice in irrigation as adopted in Dorſetſhire.

There have been ſome objections raiſed againſt irrigating by art, in the manner practiſed in Glouceſter and Dorſetſhire; but I think theſe have been founded on a ſuperficial view of the ſubject, and I agree with Mr.

Mr. Wright in the arguments which he uſes to refute them. If it is ſaid that much land is wanted in cutting the drains, trenches, and mains, may it not be aſked, with propriety, if the land does not produce three times as much graſs as before; and if this is not to be conſidered among the moſt intereſting kinds of gain which can be added to annual income?

If it is ſaid to be expenſive; let me aſk, if the money thus ſunk in ameliorating the farm, does not return a better intereſt, and a more permanent one, than could have been obtained for the ſame ſum elſewhere?

If it is ſaid that the hay of theſe meadows is not ſo good as others; it may be replied, that *the beſt proof of a pudding lies in the eating:* for Mr. Wright aſſures us, that he has ſeen a cow, fatted wholly with this hay, which ſold for twenty pounds *.

Some again, it ſeems, have raiſed an objection to paying millers for the uſe of water. If this were a general caſe, it would apply with ſome degree of weight, but not inſurmountably. Mr. Wright gives as a

* Wright on the Water Meadow of Glouceſter, p. 14.

proof of this, that one meadow of ſixteen acres, in his pariſh, pays ſix guineas per annum to a miller for the uſe of his water; and if the proprietor did not find his account in it, he would certainly decline it. My plan for national irrigation, not only removes this objection totally, by taking water from lakes, ponds, and rivèrs, but goes to aſſiſt both the miller and navigable canals with ſurplus water; and may furniſh the irrigator with ſea water, containing ſalts in abundance.

If we are permitted, however, to credit the reſpectable clergyman who has communicated the Glouceſterſhire mode of irrigating, no man ever yet repented a fair experiment.

The Author of a work juſt publiſhed, under the title of the *New Farmer's Calendar, or Monthly Remembrancer*, a book which it is to be hoped will prove of ſome importance to practical farming, conſiders irrigation as a very excellent, though at the ſame time he ſays, an expenſive and frequently difficult mode of improvement: if the object of a farmer's care, however, is admitted, as in other occupations, to contemplate the greateſt and moſt ſpeedy accumulation of capital ſtock as its chief end, then expence will prove only a relative drawback

back upon a greater quantity of produce, which gives the cultivator an increaſe of profit that he could not by any other means attain; and he will find himſelf poſſeſſed of all the benefits of overflow and depoſited ſediment, which the Remembrancer confeſſes, without dreading thoſe difficulties which judgment and perſeverance are competent to conquer.

Although this writer, as he acknowledges, has never paid much attention to the practice of irrigation, he has certainly hit upon ſome of its beſt principles, in applying it to the growth of the crop, or the amelioration of the ſoil: the chemical virtues which it imparts to the earth are doubtleſs to be admitted as a gratuitous manure, which might otherwiſe become waſted, or generate nuiſance: and I heartily accord in his regret, that any ſpring or river in his majeſty's dominions are ſuffered to waſte the moſt material particles of nature's fructifying medium, when the various ſtreams might be eaſily diſtributed to the reſpective calls of irrigation, without depredating the ordinary properties of their pre-exiſting functions. The Author of this Calendar eſtimates the irrigation of an acre of meadow at a ſum which would go far to

overturn my ſyſtem; yet it is the object of my ſyſtem to overturn his expence; and we may perhaps ultimately be both of us right in this ſeeming contradiction. An acre of meadow land, he ſays, will coſt from three to ſeven pounds to prepare it; that is, between three and ſeven, or an average of five pounds for each acre of a farm, I preſume, which an individual undertakes to irrigate, including command of water; and, conſequently, this expence muſt be repeated in the undertakings of each and every individual. Yet if the *nation* were to undertake a *ſyſtem of irrigation*, I apprehend the repetition of the heavieſt items may be avoided; and the beauties of Mr. Adam Smith's chapter on the diſtribution of labour would be aſtoniſhingly exemplified. The illuſtration which this Gentleman has choſen, by adopting a ſelect inſtance of improvement in Glouceſterſhire, will, in any event, add ſtrength to my propoſition, by the demonſtration of profit. On the 2d day of April, ſays he, 107 ſheep, 8 cows, and 7 colts, were fed on a piece of old watered meadow of eight acres, during five weeks; that is to ſay, until the time of ſhutting up for the hay crop, for the keep of which the proprietor

etor received £.35 1s. 10d. after the rate of 10d. a head per week for the ſheep, 3s. 6d. for the cows, and 4s. the colts. The crop of hay was afterwards about fifteen tons, which was ſix weeks in growing.

Such a profit as this, is, I apprehend, ſeldom drawn from commercial capital; yet it ſhould be remembered, that irrigation gave this as a ſpecimen of permanent production; not barely of rent, which, like commerce, might be uncertain, and ſubject to a fluctuation of proceeds according to the tide of fickle prejudice, or capricious opinion.

In caſes where permanency of ſituation, and durability of materials, are objects of moment, or where the preference and circumſtances of the party may juſtify a proportionate expence, the hydraulic machine, upon an improved *Noria* principle, which is now offered to the public by Meſſrs. Dixie and Mapleſtone, at their Factory in London, may be uſefully applied, and increaſed to any given ſize or capacity.

The one in daily uſe at their factory is forty feet elevation from the lower level to the bottom of the upper ciſtern; and, it is ſaid, it can raiſe one hundred gallons per minute

minute by one man's labour. The buckets are made of elm, fitted upon two ropes; ſo that one bucket ſerves as a cover to the other in their aſcent: by which means, I conceive, they may not only be conſtructed ſo as to ſerve each other for lids, but the rotary movement they perform round the drum, pin, or ſpocket wheel avoids all but the lateral preſſure of the atmoſphere; which, comparatively conſidered, can ſcarce be admitted as friction. This method of avoiding any other reſiſtance than the actual ſpecific gravity, and its progreſſive accumulation with the increaſe of diſtance from the revolving axis, ſeems to fit this machine more particularly than the Spaniſh Noria, to many uſeful purpoſes, where a great elevation is demanded; though, perhaps, the cheapneſs of the Noria, and the capacity of many other cheap yet powerful machines that are now in uſe, have a preference, where only a ſmall degree of aſcent is required.

The coſt of this machine is five ſhillings per foot running meaſure; ſay ten ſhillings per foot perpendicular height, beſides extra charges, which may perhaps amount to between

tween ſix and ten guineas more for one of forty feet elevation.

In caſes where it may be convenient to uſe this machine for draining lands from a lower level to a higher, I apprehend the addition of a little expence in reſpect to a few feet elevation, may be conſidered economical; for by this means the water, which it becomes neceſſary to diſcharge, may be thrown into the buckets of an overſhot wheel without the expence of a dam; and, in mountainous countries, may be applied to an extent of machinery, and perhaps to a ſucceſſion of water-falls, without any extra expence in regard to a firſt moving power, which may thus be counted clear gain.

It is hence extremely obvious to me, that a very intereſting application of this apparatus may be made to many of the great mechanical and manufacturing purpoſes of Great Britain; and perhaps to thoſe of agricultural irrigation; the feeding of canals; and the watering of cities. There is one great uſe, however, which occurs to me, in which I think the more wealthy proprietors of houſes may profit by the adoption of it into their ſyſtem of houſehold economy. It has a capacity to ſpare all the cuſtomary water

water carrying up ſtairs, becauſe, by the extenſion of its diſtributive pipes, the water may be more eaſily conducted into every room in the houſe by the labour of one man, than ten pails, perhaps one, full, can be carried up to the garrets.

In paying a juſt tribute to the merits of this profitable machine, we ſhould nevertheleſs remember that the idea is by no means new: Meſſrs. Dixie and Mapleſtone are too well inſtructed in their profeſſion, and too candid to invade the leſs improved merits of the Noria, or the more antient claims of Coſtar, who ſeems to have been the father of chain pumps, and the great grandfather of many improvements in the hydraulic art, which have ſucceſſively uſurped their patented ſtation in the pedigree of mechanic genius; and in the collateral application of his principles to ſolid operations.

The proprietors of this uſeful implement in its preſent improved condition ſeem to be contented with manufacturing it with buckets of wood, copper, pewter, or earthen ware, giving preference to pewter for its ſweetneſs and durability; and they recommend it for the deepeſt wells, mines, quarries,

ries, coal pits, navigations, breweries, diſtilleries, &c. for which its rotary movement is particularly adapted.

In Switzerland, they have an invention ſimilar to this, which they apply to a pump by way of valves: a rope is reeved through the bore of the pump, which is left open at both ends; blocks of wood, of an oval figure, are threaded upon this rope in the manner of beads, and are confined to a particular ſpace from each other, by means of knots in the rope, which is formed into an endleſs ſtrap, paſſing round a drum wheel below the pump; and round a ſprocket wheel above it, this ſtrap pulls the blocks through the pump barrel, forcing the water before it. I have ſeen it in uſe in Spain, but the friction is great and diſorderly, and I think it better diſpenſed with.

Of

Of Irrigation by means of Warping.

It is much to lamented, that in the preſent ſtate of agricultural ſcience, it is not eaſy for men in general to comprehend many local and technical terms belonging to huſbandry, which, properly ſpeaking, are fitting ſubjects for a Gloſſary. The reflections of the Board, it is to be hoped, will in due ſeaſon be awakened by this deficiency; and if their able Secretary could find time to form a more complete Agricultural Dictionary, progreſſively as words occur, in addition to thoſe which are already explained, it would probably be found capable of fixing a national ſtandard, and would prove a treaſure in huſbandry. A term offers on the ſubject I am at preſent about to notice, which may ſerve as an example: the word warping, which is technically applied to towing of ſhips, and preparing webs of cloth for the weaver's loom, is alſo, I find, applied in agriculture to deſcribe that ſpecies of irrigation which depoſits a quantity of ſediment from the flowing tide, and which forms a ſtratum

ſtratum of ſoil or manure when the waters have receded from it.

This definition of the word appears to be chiefly limited to tide water flowing from the ſea; though the nature of the accumulation ſeems to be nearly the ſame with the ſiltage of freſh-water rivers, the redundancy of which, by way of diſtinction, is called flooding.

This operation, whereby ſoil is created, is ſaid to have originated within a few years of the preſent time; and various counties in England lay claim to the diſcovery, without any degree of acknowledgment to the tuition of Egyptian huſbandry. A late work, entitled the Remembrancer, or Farmer's Calendar, attributes the primary practice to the county of Lincoln, while others beſtow the laurels on the county of York: but all ſeem to agree, that although the works are, in the firſt inſtance, expenſive, there are few, if any, caſes where money can be more advantageouſly laid out.

The fertility of the Nile affords a ſtimulus to exertion, which ſhould be ever preſent before the warper; and I avail myſelf of a few Britiſh examples which Sir John Sinclair has kindly ſuggeſted to me, for the purpoſe of

of rendering this diſcovery more generally known.

The practice of warping, although one of the moſt important improvements in huſbandry, is ſo local, ſo limited in its extent, and ſo partially underſtood, that I ſhall need no apology for dwelling at ſome length upon the ſubject: ſo far, indeed, as examples have occurred through this reference, or in the ſurveys reported to the Board of Agriculture, I muſt beg the popular indulgence, and avail myſelf of the means which are to be obtained for rendering my book more diſtributively uſeful in agricultural experiments and practice.

Whether this ineſtimable ſcience owes its birth to the inundations of Egypt, or to more modern diſcoveries, is, perhaps, a queſtion of ſome doubt: ſo far as the practice has become known and propagated under the term by which it is deſignated in this country, England, it is even doubtful. The Weſt Riding of Yorkſhire, we find, lays claim to its originality; though the nature of the fens in Lincolnſhire and Cambridge ſeems to indicate an equal pretenſion on their parts. In either caſe it is obvious that the richeſt kind of ſuperſtratum is created by it;

and

and the Agricultural Surveys, where this ſpecies of improvement has been noticed, are in uniſon to ſupport this more eſſential concluſion.

The method recommended by Lord Hawke * is, to bank the land, which is to be warped, againſt the river; ſloping the banks on each ſide of their crown or top, at the rate of three feet to every one foot perpendicular riſe. The height and breadth of the top will, of courſe, be regulated by the ſtrength of the tide and depth of the water; for the object is to command the land and water at pleaſure. The openings or ſluices in the banks are a ſmaller or greater number, according with the extent of the land to be warped, and the fancy of the proprietor; but, in general, there are only two ſluices; one called the *floodgate*, to admit; and the other called the *clough*, to let off the water gently. Theſe, Lord Hawke ſays, are enough for ten or fifteen acres.

"When the ſpring tide begins to ebb," ſays his Lordſhip, "the floodgate is opened to admit the tide, the clough having been previouſly ſhut by the weight of water

* See Agricultural Survey of Yorkſhire (W. R.) p. 164.

brought up the river by the flow of the tide. As the tide ebbs down the river, the weight or preſſure of water being taken from the outſide of the clough next the river, the tide-water that has been previouſly admitted by the floodgate opens the clough again, and diſcharges itſelf ſlowly but completely thro' it. The cloughs are ſo conſtructed as to let the water run off, between the ebb of the tide admitted, and the flow of the next; and to this point particular attention is paid. The floodgates are placed ſo high as only to let in the ſpring-tides when opened: they are placed above the level of the common tides."

We learn, alſo, from his Lordſhip's account that it is cuſtomary to plant willows *in front* of the banks as a protection; but not *on* the banks, becauſe this would give the wind a ſufficient power to ſhake and injure them.

Lands ſituated like thoſe at Radcliffe, *beneath the level of the ſpring-tides*, appear to be the moſt ſuitable for warping; although it is the practice to warp thoſe of other deſcriptions, and to warp one year in ſeven, which is deemed ſufficient.

Lord Hawke mentions an inſtance of a field

field of *good-for-nothing* corn land, which was raiſed to fourteen inches of warp in three years, and then ſowed with beans. From this crop he expected eight quarters. The warp conſiſts of the mud and ſalts which the ebbing tide depoſits; and this is more or leſs according to the diſtance from the Humber. Near Howden, ſays my Lord, one tide will depoſit an inch of mud. "Cherry Cob Sands," ſays he, "were gained from the Humber by warping; they are ſuppoſed to be four yards thick of warp at leaſt; ſome of thoſe were ploughed for twelve, fourteen, or ſixteen years, before they would grow graſs ſeeds. The land," ſays he, "muſt be in tillage for ſome conſiderable time after warping—for ſix years at leaſt. The land, if laid down to graſs, and continued in graſs, is not warped; for the ſalts in the mud would infallibly kill the graſs ſeeds. When it is propoſed to ſow the land again with corn, then the land is warped; when they find the graſs decline, then they warp and plough it out. As the land varies in quality, ſo does the time in which it will produce good graſs: the land is never fallowed but in the year when it is warped."

* Mr. Day, of Doncaſter, conceives the practice of warping in the low part of the weſt riding of Yorkſhire, to have originated from the tides overflowing the banks of the river, and depoſiting a ſediment which was found to produce luxuriant crops of corn. A farmer, it ſeems, gained light on the ſubject from this caſualty; and obtained leave to lay a tunnel of a few inches ſquare through the embankments of Hatfield Chace, for the purpoſe of warping his lands, on giving a ſatisfactory ſecurity in regard to the conſequences of his undertaking. It is ſaid, by this gentleman, that warping has only been ſpreading its beneficial influence by *artificial* practice, in this country, about twenty or twenty-five years. It is to be hoped, however, that the intereſting advantages we ſhall be enabled to exemplify in this book, will contribute ſpeedily to extend this very profitable acquiſition towards the extermination of ſcarcity.

Mr. Day conſiders the expence of warping to be influenced greatly by the ſituation of the lands, and the courſe and diſtance which the warp is to be conducted. He

* Ag. Rep. W. R. Yorkſhire, p. 166.

ſays,

ſays, " 1ſt, The ſituation of the lands is to be conſidered. 2dly, The quantity of land the ſame drains and cloughs will be ſufficient to warp. 3dly, The expence of building the cloughs, cutting the drains, embanking the lands, &c. An eſtimate of which expence being made, then it will be neceſſary to know the number of acres ſuch cloughs and drains will warp, before any eſtimate per acre can be made."

It is thus clear, that the expence of warping per acre will depend greatly on the extent of land which may be overflowed by one and the ſame ſet of drains and cloughs. Mr. Day thinks that great quantities of land in the country might be warped at ſo ſmall an expence as from four to eight pounds per acre; and he ſtates the advantages gained at various rates, from five to fifty pounds per acre; and conſiders the greateſt advantage to ariſe from warping the worſt and moſt porous land *.

In enumerating the advantages that accrue from warping, this gentleman ſays the land will bring very large crops for ſeveral years afterwards without any further manure; and

* Ag. Survey York. W. R. p. 168.

that warping may be eaſily repeated at a ſmall expence by opening the old drains, which may ſerve in the interim for draining the land if it ſhould be neceſſary. He recommends the culture of oats for the firſt crop after warping; and thinks this practice better adapted to oats, wheat, or beans, than to barley; which laſt is rendered too ſtrong and coarſe by the great fertility of the ſoil. He recommends, however, a coat of warp whenever the land is fallowed; and conſiders this management, above all other kinds, the cheapeſt, when properly applied.

Mr. Day defines *warp* to be the ſediment left upon the land by flooding it with *tide* water. It ſeems to be the letting in water where the tide flows that is termed *warping*; letting in freſh water from a river, though by a ſimilar operation, would be called *flooding*, and not *warping*. The benefit derived from warp appears to reſt in the ſaline particles, and a greater depoſit of ſediment than can be generally obtained from freſh water floodings. He recommends June, July, and Auguſt, as the beſt months for warping; becauſe, at this ſeaſon the ſoil is in its dryeſt ſtate, and of courſe the moſt ſuſceptible of thoſe impregnations and acquiſitions

quiſitions which are received in the acts of abſorption and adheſion. He conſiders wet ſeaſons the leaſt proper for warping; becauſe the redundancy of freſh water, which becomes mixed with the muddy tide muſt neceſſarily weaken the ſaturation, and render it leſs capable of depoſiting ſediment. Land thus manured is deemed to be the beſt for potatoes, and far the moſt productive.

The depth of the water to be uſed for warping, will vary according to the ſurface of the ſoil; nor is it material that it ſhould be always at the ſame height, although it is well to retain a depth of three or four feet where the ſituation and embankments will admit of it. Mr. Day attributes the firſt experiment in warping to Mr. Richard Jennings, of Armin near Howden, about fifty years ago. It was next attempted, he ſays, by a Mr. Farham, ſteward to a Mr. Twiſleton of Rawcliffe; and by a Mr. Mould, of Potter Grange, about forty years ago; ſince when it has been gaining ground in practice. I merely mention theſe particulars as a reference to claims for the honour of this uſeful diſcovery, without any deſign to change the ground on which I find the various pretenſions.

The Secretary to the Board of Agriculture has paid minute attention to the ſubject of warping in the County of Lincoln; and ſpeaks of it as one of the moſt ſingular and intereſting improvements in huſbandry which he has any where heard of *.

"The water of the tides that come up the Trent, Ouze, Dun, and other rivers," ſays he, "which empty themſelves into the great eſtuary of the Humber, is muddy to an exceſs; in ſo much, that in ſummer if a cylindrical glaſs, twelve or fifteen inches long, be filled with it, it will preſently depoſit an inch, and ſometimes more, of what is called *warp*. † Where it comes from, is a diſpute.

* See Ag. Surv. of Lincoln, p. 216.

† A ſimilar queſtion ſuggeſted itſelf to my mind a year or two ago, on obſerving the accumulation of ſilt in the Ouſe, and other rivers of the fen countries, ſince the period of the Roman poſſeſſions there, as repreſented in the looſe exiſting documents concerning drainage. It appears to me to be a matter of importance to the engineering of that country, to aſcertain the preciſe points of deep water outfall into the North Sea; and to trace, as far as practicable, the exact tendency of the *undertow* channel, even to the fartheſt extent of ſoundings: for it would ſeem to be a fruitleſs operation to repeat a ſyſtem of error, which drains one man's land to drown another's; and which will for ever be the caſe while a mere

diſpute. The Humber, at its mouth, is clear water; and no floods in the countries waſhed by the warp rivers bring it, but, on the contrary, do much miſchief by ſpoiling the warp.

In

mere ſurface-view of the ſubject is palmed upon the parties concerned, for profeſſional knowledge. An inveſtigation of the *reports* on this particular, when made by men of ſcience, will eaſily diſcover the *fortunate* man to whoſe *popular* opinion I allude; I truſt the very honourable profeſſion of engineers, to ſeveral of whom I am now perſonally known, will not think me ſo illiberal as to hint at any *general* reflection. To return however to the *point*, I have often been perſuaded that the extreme degree of ſiltage which theſe rivers admit, owes its exiſtence to a cauſe ſo far back, that it muſt for ever hinge on conjecture. The ſections of the land on the coaſt of France and England, as well as the intermediate ſoundings, and the action of the tides upon the part called the *Rip Raps*, (from the motion which the meeting of the waters occaſions), indicate very ſtrongly, I think, that the period once exiſted when the countries of France and England formed one land; and the channel itſelf was no more than a river. However ſurpriſing it may be thought, at firſt view, that ſuch an aſtoniſhing convulſion of nature ſhould have happened, as that which muſt have been required to rend and ſeparate ſuch a vaſt body of earth, and to ſcatter it about in the North Sea, from whence the continual friction of the tides muſt have been gradually ſhifting it about for many thouſand years, it is

not

In the very drieſt ſeaſons, and longeſt droughts, it is beſt and moſt plentiful. The improvement is perfectly ſimple, and conſiſts in nothing more than letting in the tide

not wholly improbable or without corroborating examples which are better known to us.

The remains of the *Godwin Sands* are a *diſcernable* ſubject; and records afford a more diſtant knowledge of their hiſtory.

Chartley-moor, in Lancaſhire, according to *Leland*, Vol. VII. p. 49. (See Lancaſter Surv. p. 105.) was the ſubject of an extraordinary convulſion in former days; and the hiſtorical account informs us, that not only a part of that tract of land was precipitated into the river Merſy, but that it was alſo diſtributed along the ſhores of Wales, the Iſle of Man, and even ſome of it into Ireland. A ſimilar breach, on this ſmall ſcale of extraordinary events, happened many years ago at Daggenham, upon the river Thames; and there are many other inſtances in Great Britain.

In the year 1782, I was myſelf on board a veſſel then cruiſing along the American coaſt, at a place called *Harvey's Quarters*, not far from the mouth of Little Egg-harbour river; and, in viewing ſeveral wrecks which were viſible at low water, a Mr. Willis, then on board, aſſured me, that, within thirty years before that time, he had purchaſed mellons of Mr. Harvey's negroes, who then reſided at that eſtate, which was a conſiderable tract of land: at preſent the ſhoals formed by its remains extend far from the ſhores of the main land.

I think

tide at high water, to depoſit the warp, and permitting it to run off again as the tide falls; this is the aim and effect. But to render it efficacious, the water muſt be at command, to keep it out and let it in at pleaſure; ſo that there muſt not only be a cut or canal made to join the river, but a ſluice at the mouth to open or ſhut as wanted; and that the water may be of a proper depth on the

I think whoever has been among the Bahama Iſlands will agree with me, that there are viſible traces there of a country, which has been formerly united with the American continent.

The traditions of the Seminola Indians aſſert, that it is not many generations back that their anceſtors croſſed the Gulph of Mexico, in canoes, to the Iſland of Cuba. This ſeems to have been equally probable in reſpect to the Grand Bank of Bahama, which ſeems not to be leſs practicable; and there are alſo very probable proofs, even yet to be ſeen, which induce a rational ſuppoſition, that the whole Weſt-India Iſlands formed a part of the weſtern terra firma. To men of ſcience I dare yet be farther bold by putting the queſtion, whether, in conſidering the current of the Gulph-ſtream, and the viſible iſlands, rocks, and ſoundings, which pourtray the line of terrene affinity acroſs the Atlantic Ocean, from the banks of Newfoundland to the Canarian coaſts of Africa, ſtill more important philoſophical queſtions are not ſuggeſted?

W. T.

land

land to be warped, and alſo prevented flowing over contiguous lands, whether cultivated or not, banks are raiſed around the fields to be warped, from three or four to ſix or ſeven feet high, according to circumſtances. Thus, if the tract is large, the canal which takes the water, and which, as in irrigation, might be called the grand *carrier*, may be made ſeveral miles long; it has been tried as far as *four*, ſo as to warp the lands on each ſide the whole way; and lateral cuts may be made in any direction for the ſame purpoſe, obſerving, however, that the effect leſſens as you recede from the river; that is, it demands longer time to depoſit warp enough. But the effect is very different from that of *irrigation* *; for it is not the water that works the effect, but the mud, ſo that in floods the buſineſs ceaſes, and alſo in winter; and it is not to manure the ſoil, but to create it †.

What the land is, intended to be warped, is not of the ſmalleſt conſequence; a bog, clay, ſand, peat, or a barn floor—all one: as

* I diſtinguiſh this *ſimple* irrigation. W. T.

† I ſhould call ploughing, for the purpoſe of burying or turning in a ſediment thus depoſited, a manuring by means of compound irrigation. W. T.

the

the warp raiſes it in one ſummer from ſix to ſixteen inches thick; and in hollows, or low places, two, three, or four feet, ſo as to leave the whole piece level.

Thus a ſoil of any depth you pleaſe is formed, which conſiſts of mud of a vaſt fertility, though containing not much beſides ſand; but a ſand unique.

Mr. Dalton, of Knaith, ſent ſome to an eminent chemiſt; whoſe report was, that it contains mucilage, and a very minute portion of ſaline matter; a conſiderable one of calcareous earth; the reſidue is mica and ſand; the latter in far the largeſt quantity; both in very fine particles. Here is no mention of any thing argillaceous; but from examining in the fields much warp, I am clear there muſt be clay in the ſame, from its caking in ſmall clods, and from its cleanſing cloth of greaſe almoſt like fuller's earth.

A conſiderable warp-farmer told me, that the ſtiffer warp was the beſt; but in general it has the appearance of ſand, and all glitters with micaceous particles.

So much, in general, as to the effect: the culture, crops, &c. are circumſtances that will beſt appear, with others, in the following notes taken on the ſpot.

The

The firſt warping works which I viewed were at Morton Ferry, where Mr. Harriſon, who ſhewed me them, has a large concern in a very great undertaking, no leſs than to warp 4620 acres of commons, by means of an act of incloſure and drainage. They are attempting to warp four hundred acres in one piece, which is to be ſold to pay the expence of doing all the reſt, and they have been offered 30s. an acre rent for it, when finiſhed: a double ſluice is erected to take the water from the Trent, which coſt 1200l. and a double canal, cut under the idea that water ſhould come in by one, and return by another; this apparently has created a great expence.

They have uſed fifteen tides over 200 acres, which has raiſed about ſix inches of warp in ſome places, but not uniform: and the opinion of the beſt informed perſons is, that they muſt divide it into fifty-acred pieces, and do one at a time. All this may be eaſily corrected, and the improvement will be amazingly great. The common is worth nothing, as it has been hitherto fed.

This ſtatement by the Secretary of the Board of Agriculture is followed by an official report and eſtimate concerning the premiſes;

premiſes; and by many other intereſting notes. From theſe, I ſhall ſelect ſuch particulars as promiſe an advantageous reſult through this preſent medium of diſtribution.

The whole quantity of waſte land incloſed, appears, as before ſtated by Mr. Young, to be 4260 acres by actual ſurvey, 2600 acres of which is low land capable of being warped; the remaining 1660 acres high land.

The ſurface is a very level one, but admits of a ſufficient fall for competent drainage. Two appertures of eight feet wide, and ten feet high, each, are recommended for the warping-ſluices of this undertaking. The warping drains to be 18 feet wide at bottom, 26 feet at top, and 4 feet deep; and to have a foreland of 4 feet, with banks on each ſide of 14 feet baſe, 6 feet top, and 5 feet high each.

Another drain, in theſe works, to be 24 feet bottom, 32 feet top, and 4 feet deep, with forelands, &c. as aforeſaid: this drain leads to the *outfall*. Three ſluices, of 10 by 8 feet, are appropriated to the uſe of the three drains which diſcharge at this point; and

and the fluices are laid 2 feet lower than low-water mark. The following, as reported, is an

Eſtimate of the Expence.

	£.	s.	d.
Cutting the catch-water drain, 400 chains, or 3696 *floors* of earth, at 3s. each -	554	8	0
Cutting a main-drain, or warping-drain, 258 chains, or 3746 floors, at 4s. each -	749	1	0
Cutting a main or warping-drain, 276½ chains, or 4015 floors, at 4s. each - - - -	803	0	0
Cutting a main-drain, 100 chains, or 1848 floors of earth, at 4s. per floor - - -	369	3	0
Warping-fluice near Morton	400	0	0
Ditto, near Walkerith -	400	0	0
Outfall ditto near Ravenfleet -	600	0	0
Carried forward,	£.3875	12	0

Amount

	£.	s.	d.
Amount brought forward,	3875	12	0
Road-bridge near Morton -	150	0	0
Ditto at Swanſea Bridge -	180	0	0
Two culvers under the warping-drains, at 100l. each - -	200	0	0
	4405	12	0
Contingencies, 10 per cent.	440	10	0
Total	£.4846	2	0

Various valuable examples here follow on the ſame authority.

At Althorpe 300 acres are improving from an inferior ſtate to 30s. per acre. At Knaith an experiment aſcertains warp to be equal to dung. Similar undertakings at Amcots. At Gainſborough a ſpot was warped to the depth of 10 inches in eight hours. When a bank breaks in warping works upon the Trent, they ſurround the ſpot with a new ſemi-circular bank, in order to let in the warp, which fills it up preſently.

The improvements by warping, which Mr. Webſter has made at Bankſide, (which is within the county of York) merit particu-

lar attention. His farm contains 212 acres of land, all warped. It coſt him 11l. per acre, and he would not now take 70l. for it. He thinks it worth 80l. per acre generally, and ſome parts worth 100l. The whole expences of his improvements did not exceed 2,500l. or 12l. per acre. A neighbour below him offers 5l. per acre for the uſe of his ſluice and main cut to warp 300 acres; which amounts to 1,500l. and reduces the expence of Mr. Webſter's works to 1000l. Take it, however, at the higheſt, and ſay that the land coſt 11l. and the improvements 12l. per acre, making 23l. and he will gain, by a ſale at 70l. per acre, 47l. per acre, or 9,964l. upon the operation.

The depths warped, in this inſtance, in four years, were 18 inches, 2 feet, $2\frac{1}{2}$ feet, &c. This Gentleman has warped ſome land which, before warping, was moor land, worth only 18d. per acre; but it is now as good as the beſt: ſome of it would let at 5l. per acre for flax and potatoes; and the whole at 50s. He has 20 acres that was warped 3 feet deep, between the beginning of June and end of September; and 18 acres, part whereof is $3\frac{1}{2}$ feet deep of warp.

This

This Gentleman has alſo applied warping on ſtubbles in autumn, by way of manuring. The crops have been very great; of potatoes, from 80 to 130 tubs per acre; each tub meaſuring 36 gallons, and ſelling at 3s. to 3s. 6d. per tub for the round kind; and at 5s. to 8s. per tub for the kidneys: this, at the preſent price, May, 1800, at 2d. per pound in London, would be an enormous product.

* Twenty acres, warped by this Gentleman in 1794, could not be ploughed for oats in 1795; he therefore ſowed the oats on the freſh warp, and ſcuffled in the ſeed by men drawing a ſcuffler, allowing nine men to a ſcuffle: three acres of this, meaſured ſeparately, afforded 14 quarters 1 ſack per acre. I very much doubt that the boaſted crops of Kentuckie have exceeded this.

Mr. Webſter alſo warped 12 acres of wheat ſtubble, and ſowed it with oats, in April, which produced 12 quarters per acre: then wheat, 36 buſhels per acre; never leſs than 30 buſhels per acre.

Six acres of beans, ſays Mr. Young, produced 30 loads per acre, or 90 buſhels; and one acre, meaſured for a wager, went 9

* See Survey of Lincoln, p. 283.

buſhels over this. Theſe lands have produced 144 pods from one bean on four ſtalks; and Tartarian oats 7 feet high. One piece warped in 1793, produced oats in 1794, at the rate of 6 quarters per acre: white clover and hay ſeed were ſown with them, mown twice the firſt year; the firſt cutting yielded 3 tons of hay per acre; the ſecond 1 ton; and after that an immenſe eddiſh.

The great beauty of this ſpecies of improvement ſeems to conſiſt, not only in the capacity for creating ſoil altogether, but alſo in the eaſe with which land can always be reinſtated or refreſhed at ſmall expence. Flax produces on warp lands 40 to 50 ſtone per acre.

A ſluice for warping, 5 feet high, and 7 feet wide, will warp 50 acres per annum; and perhaps 70 acres, if the land lies well, and near the river. The coſts will be from 400l. to 500l.

Warped lands, at Reeveneſs, has ſold for 100l. per acre. Lord Beverley has ſix or ſeven ſluices going, and has warped 300 acres in a year.

Twenty-four thouſand pounds was, ſome time paſt, expended in making a canal from the river Trent, near Althorpe, to Thorne, &c.

&c. This is a navigable canal of 40 feet bottom, and deſigned for warping a vaſt extent of country. A branch to Crowle is laid out; and another from Thorne to the river Dun: theſe are for navigation; and on each ſide of the navigable canals are ſokage drains for relieving the overflowing waters of the country, and at other times admitting tide water for the proceſs of warping. It is propoſed to make cuts of twelve miles, at right angles, for the purpoſe of felling warp to the country, and for delivering through ſluices on either ſide, as occaſion requires. The price propoſed is from 4 to 5 pounds per acre; and proviſion againſt ſiltage of the works, &c. is made ſo that the ſokage drains can be ſcoured or ſupplied by means of ſluices from the navigable canal.

* Mr. Nicholſon, of Rawcliffe, (which is alſo in Yorkſhire) takes the levels firſt, and builds a ſluice. If he has to convey the warp the diſtance of a quarter or half a mile, ſixty acres may be done the firſt year; but the drier the ſeaſon the better. The clough or ſluice, &c. is 8 feet wide, and 5 or 6 feet high. Drains 14 feet at bottom, and as

* See Agricul. Survey of Lincoln, p. 284.

much more at top. Banks are 4 to 8 feet high. He begins at Lady-day, and continues till Martinmas. Three inches of warp will produce great crops, and they will be as good at ſix inches as at ſix feet. Warp is cold, and, if deep, takes time: a dry year is the beſt. Crops ought to be, beans 20 loads; wheat 10 or 12 loads; oats 10 quarters; never barley: after ſix years, potatoes and good flax. Mr. Nicholſon makes it worth 40 or 50l. per acre. By keeping up the ſluices and drains, land can always be refreſhed at any time. Crops of flax on this kind of land have been ſold at 10l. per acre ſtanding; it is afterwards ſown in rape. Theſe lands Mr. Nicholſon had warped to a level, on a ſlope gradually accumulating warp from the depth of two feet to ſix inches.

At Snaith ſand land for the plough has ſold at 100l. per acre.

Warp is ſaid to leave an eighth of an inch every tide: hence we have a datum for regular calculation; and, if we take away the ſediment which is depoſited, for the purpoſe of manuring the higher lands, we may eaſily eſtimate the time when the tides will reinſtate

inſtate the warp, and add ſo much clear gain to the quality of the upland eſtate.

Warp is ſaid to be left on the premiſes in diſtinct and ſeparate flakes, not in one conſolidated maſs; the water ſhould be made to run perfectly off, that the warp may incruſt; and this cannot be the caſe if much water is ſuffered to remain in the drains: thus, where there is only one ſluice, it can only be uſed every other tide.

On the ſea coaſt, from Wiſbeach to Boſton, there is much ſilt or warp; and ſome experiments have been tried by Major Cartwright and others, which ought, from their favourable reſult, to ſtimulate farmers to carting or boating this kind of manure to their upland farms, where they have not the means of irrigating in the uſual method, and can procure the warp within a practicable diſtance.

Much, in this reſpect, muſt nevertheleſs depend on the combination of circumſtances which the landlord facilitates by interweaving his own intereſt in the web of his cultivator's proſperity.

To what extent this ineſtimable improvement will be extended in the courſe of a few years, it is not eaſy to determine. An ex-

tenſive field is left open for it in the fens of Lincolnſhire, the Bedford levels, and the adjacent country; and it reſts with land proprietors in thoſe parts to benefit themſelves, by enabling others to better their condition in the enterprize. If this is not done, while the accepted day is preſent, we may venture to predict that more favoured countries will become competitors for agricultural ſuperiority; for there can be no doubt that the enterprizing genius of the preſent generation will anticipate the future advantages which Britiſh experiments have brought to light in countries whoſe fertility and expanſe is by no means inferior to the warpings of the Humber, or the fructifying inundations of the recently explored territories of Egypt.

PUTRID WATER FROM THE STEEPING OF FLAX, HEMP, &c.

(Taken from the 26th §. XV. Chapter, propoſed Rep. from the Board of Agriculture.) 1795.

It is ſtated in a very valuable Report laid before the Board *, that the land on which flax was ſpread for dying, after being ſteeped in water, being greatly improved thereby, coarſe and ſour paſture being changed into the beſt ſort of graſſes, and into ſweet herbage, Mr. Billingſly was thence induced to apply it to paſture land by means of carts, ſimilar to thoſe uſed near London for watering the roads. The effect was aſtoniſhing, and advanced the land in value from 10l. to 50l. per acre. This liquid, he ſuppoſes, is much ſuperior to animal urine; and it is earneſtly recommended to the attention of thoſe who cultivate hemp or flax.

In Lincolnſhire, where this branch of huſbandry has been much attended to, they

* Somerſet Report.

find

find the ſediment of the pits, in which flax or hemp have been ſteeped, a very valuable manure; and, conſidering theſe circumſtances, it would appear that an idea commonly circulated, that flax and hemp ought not to be cultivated in this country, becauſe they are exhauſting crops, and return nothing to the ſoil, is not perfectly well founded. It has not yet been aſcertained to what extent manure from an acre of flax can be obtained, but it is probably conſiderable.

The circumſtance above alluded to naturally leads to the following obſervations:

1. It is well known that flax will grow in almoſt any part of the country, however elevated. In conſequence of the rapidity with which it grows, and the ſhort time neceſſary for its remaining in the ground, it is hardly ever injured by froſt. If, therefore, any quantity of flax were raiſed in the higher parts of our mountainous diſtricts, and was kept in ponds or reſervoirs of water there, the water might thus be converted into a uſeful manure; and irrigating the land below might convert it into excellent paſture.

2. The ſecond obſervation is, that improving water as a manure has been much leſs attended to than it probably deſerves.

To

To make it fit for that purpoſe, nothing more is neceſſary than to render it putrid. From its being in a liquid ſtate, it ſeems to be better adapted for being brought into a putreſcent ſtate than earth, and other ſubſtances of a more compact and cloſer nature. If any chemiſt could diſcover a mode of quickly rendering a conſiderable quantity of water putrid, at a ſmall expence, he will probably do more for the improvement of agriculture, than could poſſibly be effected by almoſt any other diſcovery.

The moſt likely mode is to collect it into pools, render it ſtagnant, and put green vegetable ſubſtances in it: this will produce putridity in the ſpace of a few days.

To the above account the following is ſubjoined: putrid water, it would appear, muſt poſſeſs the ſingular property of extirpating that part of the grameneous tribe which are adverſe to the purpoſes of the grazier and farmer, or of changing (as here ſtated) the coarſe and ſour graſſes into that ſweet herbage agreeable to his wiſhes. This quality of water will certainly be worth attending to. In Devonſhire water is meliorated by lime in ponds, there known under the name of *preſidents*; which are ponds enriched by the drain

drain of an adjoining *linhay*, or yard, with the addition of a bag of lime at different times.

The author of the preſent work begs leave to add, that he ſaw in 1790, at a villa belonging to William Alexander, Eſq. near Richmond, in Virginia, a pool conſtructed in the center of a new garden, in a poor ſandy ſoil, into which the water was conveyed by pipes: theſe pipes communicated to a pump erected in a houſe at the end of the garden, wherein all vegetables gathered for the table were prepared by the gardener, who was a Frenchman. A ciſtern, with holes in the bottom, was placed beneath the ſpout of the pump, ſo that when the vegetables were put into it to be waſhed by pumping the water, the foul water and filth was immediately conducted into the putreſcent reſervoir in the center, from whence the garden was watered. On enquiring of the gardener why he did not diſtribute the pure water immediately from the pump? He anſwered, that no water was fit for a garden until it had been expoſed to the ſun and to the effects of putrefaction. Hence it may be ſuppoſed that this practice is common in ſome parts of France.

IRRIGATION IN THE DISTRICT OF WILTSHIRE, AS COMMUNICATED TO THE BOARD OF AGRICULTURE IN THE WILTSHIRE REPORT.

There is perhaps no part of this kingdom where the ſyſtem of watering meadows is ſo well underſtood, and carried to ſo great perfection, as in this diſtrict. This, which is ſo juſtly called, *by Mr. Kent*, "the greateſt and moſt valuable of all improvements," was generally introduced into this diſtrict in the latter end of the laſt and the beginning of this century. Many of the moſt valuable and beſt formed meadows, particularly in the *Wyley Bourn*, were made under the directions of one farmer Baverſtock, of Stockton, between the year 1700, and 1705. And at preſent there is ſcarcely a river or brook in the diſtrict that is not applied in ſome way or other to this purpoſe.

An imperfect ſcheme of watering had, undoubtedly been practiſed before that period. Perhaps, indeed, its introduction into this diſtrict

diſtrict is almoſt co-eval with that of folding ſheep, with which it is intimately connected: but the *regular mode*, in which both ſyſtems are now conducted, is certainly not very ancient. Many old farmers, who have died within the memory of man, remembered when neither of the ſyſtems was conducted on any regular plan.

The Theory of Water-meadows.

The idea of watering meadows, ſo far as it relates to bringing the water upon the land, was taken from nature. It muſt have been always obſerved, that winter-floods produced fertility, provided the water did not remain *too long* on the land.

The idea of taking the water *off* the land *at will*, and bringing it *on again at will*, is the effect of art; and the knowledge of the proper time to do this, is the effect of obſervation.

A water-meadow is a *hot-bed* for graſs. In what manner water acts upon the land, ſo as to produce a premature vegetation, before

before natural vegetation begins, is a philoſophical problem, which it is not a farmer's province to ſolve.—It was ſufficient for him to know that the fact was ſo. Obſervation on the effects of water, ſo brought on, ſoon ſhewed him at what period its good effects ceaſed, and when it began to do miſchief. This obſervation, therefore, regulated the time of keeping the water on the land; and as this period was different on different kinds of land, and at different ſeaſons of the year, it became neceſſary that they ſhould have ſuch a command of water, as to take it off immediately as ſoon as they found the ſtate of the land required it. This, by degrees, produced that regular diſpoſition of the water-carriages, and water-drains, which in a well laid out meadow, bring on and carry off the water as ſyſtematically as the arteries and veins do the blood in the human body.

As water-meadows are totally unknown in many parts of the kingdom, and but very partially known in others, it may not be thought improper, in the agricultural account of South Wiltſhire, to ſpeak a little more fully on their nature and properties. If it ſhould tend to excite the ſame improvement

ment in other counties, one of the great objects of the Board of Agriculture will be attained.

The Nature and Properties of Water-meadows.

It has been already premiſed, that the principal contrivance of a water-meadow is the power of bringing on and carrying off the water at pleaſure. And provided this great object can be accompliſhed, it is not material what the ſhape of a water-meadow is, or that the diſpoſition of the trenches, technically *the works of the meadows*, ſhould be uniform.

But as very little land can be entirely commanded by water, unleſs its inequalities are reduced by manual labour, it has been found convenient to adopt two different kinds of water-meadows, one for land lying on declivities, and which muſt in general be watered from ſprings or ſmall brooks; and the other for low land rivers, to be watered from thoſe rivers.

The

The firſt kind is called in Wiltſhire, "*catch-work meadows*;" and the latter, "*flowing meadows.*" The latter are by far the moſt general in this diſtrict.

It is impoſſible to give any fully-intelligible written deſcription of the mode of making theſe meadows: this operation muſt be ſeen, to be properly underſtood.

Catch-work Meadows deſcribed.

But to elucidate the diſtinction between the two kinds of meadows, and to give ſome idea what are the ſituations in which they may be introduced, it may be neceſſary to remark, that the catch-work meadows* are made by turning a ſpring, or ſmall ſtream, along the ſide of a hill, and thereby watering the land between the new cut, or, as it is provincially called, the main-carriage, and the original water-courſe, which now

* The "catch-work meadows," are the kind that are ſo common on the ſides of the hills in Devonſhire; and are partly deſcribed by plates under the Glouceſterſhire head.

becomes the main-drain. This is ſometimes done in particular inſtances, merely by making the main-cut level, and ſtopping it at the end; ſo that when it is full, the water may run out at the ſide, and flood the land below it. But as the water would ſoon ceaſe to run *equally* for any great length, and would waſh the land out in gutters, it has been found neceſſary to cut ſmall parallel trenches, or carriages, at diſtances of twenty or thirty feet, to catch the water again; and each of theſe being likewiſe ſtopped at its end, lets the water over its ſide, and diſtributes it until it is caught by the next, and ſo on over all the intermediate beds to the main-drain at the bottom of the meadow; which receives the water, and carries it on to water another meadow below; or, if it can be ſo contrived, another part of the ſame meadow on a lower level.

To draw the water out of theſe parallel trenches, or carriages, and lay the intermediate beds dry, a narrow deep drain croſſes them at right angles, at about every nine or ten poles length, and leads from the main-carriage at top, to the main-drain at the bottom of the meadow.

When

When this meadow is to be watered, the ends of the carriages adjoining the croſs-drains, are ſtopt with turf dug on the ſpot, and the water is thrown over as much of the meadow as it will cover well at a time, which the watermen call a *pitch of work*; and when it is neceſſary to lay this pitch dry, they take out the turves, and let the water into the drains, and proceed to water another pitch.

This kind of water-meadows is ſeldom expenſive: the ſtream of water being uſually ſmall and manageable, few hatches are neceſſary; and, the lands lying on a declivity, much leſs manual labour is required to throw the water over it regularly, and particularly *to get it off again*, than in the flowing meadows. The expence of making ſuch a meadow is uſually from three to five pounds per acre; the improvement frequently from fifteen ſhillings an acre, to at leaſt forty, per annum.

The annual expence of keeping up the works, and watering the meadow, which is uſually done by the acre, ſeldom ſo high as 7s. 6d. per acre.

Flowing-meadows deſcribed.

The other kind of water-meadows, *viz.* thoſe uſually called *flowing-meadows*, require much more labour and ſyſtem in their formation. The land applicable to this purpoſe being frequently a flat moraſs, the firſt object to be conſidered is, how the water is to be *got off* when once brought on; and in ſuch ſituations this can ſeldom be done without throwing up the land in high ridges, with deep drains between them. A main-carriage being then taken out of the river at a higher level, ſo as to command the tops of theſe ridges, the water is carried by ſmall trenches or carriages along the top of each ridge, and by means of moveable ſtops of earth is thrown over on each ſide, and received in the drain below, from whence it is collected into a main-drain, and carried on to water other meadows, or other parts of the ſame meadow below. One tier of theſe ridges being uſually watered at once, is called "*a pitch of work*;" and it is cuſtomary to make the ridges thirty or forty feet wide,

or,

or, if the water is abundant, perhaps ſixty feet, and nine or ten poles in length, or larger, according to the ſtrength and plenty of water.

It is obvious, from this deſcription, that as the water in this kind of meadow is not uſed again and again in *one pitch,* as in the catch-meadows, that this method is only applicable to large ſtreams, or to valleys ſubject to floods; and as theſe ridges muſt be formed by manual labour, the expence of this kind of meadow muſt neceſſarily exceed the more ſimple method firſt deſcribed: and the hatches that are neceſſary to manage and temper the water, or rivers, muſt be much more expenſive than thoſe on ſmall brooks.

The expence, therefore, of the firſt making ſuch a meadow as this is, will be from twelve pounds to twenty pounds per acre, according to the difficulty of the ground, and the quantity of hatch-work required: but the improvement in the value of the land by this operation is aſtoniſhing.

The abſtract value of a good meadow of this kind may fairly be called three pounds per annum per acre; but its value, when taken as part of a farm, and particularly of a ſheep-breeding farm, is almoſt beyond computation;

and when ſuch meadow is once made, it may be ſaid to be made for ever, the whole expence of keeping up the works, and watering it frequently, not exceeding five ſhillings per acre yearly; and the expence of the hatches, if well done at firſt, being a trifle for a number of years afterwards.

Suppoſed Quantity of Water-meadow in this Diſtrict.

The number of acres of land in this diſtrict, under this kind of management, has been computed, and with a tolerable degree of accuracy, to be between fifteen and twenty thouſand acres.

Indeed it has been found ſo very beneficial, that very few ſpots of land, capable of being watered, remain otherwiſe, unleſs where ſome water-mill ſtands in the way, or where ſome perſon who has the command of water above, refuſes to let it be taken out of its natural courſe to water the lands below.

Some new meadows might be made, and very great and beneficial alterations made in the

the old ones, if ſome plan could be adopted to get the command of water where neceſſary for this purpoſe; and particularly in the caſe of water-mills. A remedy for this will be hereafter propoſed.

Water-meadows do not make a Country unhealthy.

It has been alledged, by thoſe who know very little of water-meadows, that they render the country unwholeſome by making the water ſtagnant: daily obſervation proves the fact to be otherwiſe in Wiltſhire—and the reaſon is obvious. It has been already ſaid, that a water-meadow is a *hot-bed for graſs*; the action of the water on the land excites a *fermentation*; that fermentation would certainly in time end in a *putrefaction*: but the moment putrefaction begins, vegetation ends. Every farmer knows the commencement of this putrefaction, by the ſcum the water leaves on the land; and if the water is not then inſtantly taken off, the graſs will rot, and his meadow be ſpoiled for the ſeaſon.

The very principle of water-meadows will not permit water to be ſtagnant in a water-mead country; it muſt be always kept in action to be of any ſervice: beſides, many of the beſt water-meadows were, in their original ſtate, a ſtagnant unwholeſome moraſs.

The draining ſuch land, and making it ſo firm, that the water may be taken off at will, muſt contribute to the healthineſs of the country, inſtead of injuring it.

Great Advantages from Water-meadows.

It is frequently aſked, how it comes to paſs that although water-meadows are ſo uſeful as to be almoſt indiſpenſible in South Wiltſhire, yet in other counties, where they are not known, the want of them is not felt; nay, that there are, even in this diſtrict, many pariſhes who have none, and even breed lambs without them?

To this it is anſwered, that the fair queſtion is not, "How do other countries do without them?" but, "How could the farmers of this diſtrict, who are happy enough to have water-meadows, purſue their preſent

preſent ſyſtem, of ſheep-breeding if thoſe meadows were taken away?" A ſyſtem which is ſaid to be more profitable to themſelves, their landlords, and the community at large, than any other that could be ſubſtituted in its room; and perhaps this queſtion cannot be anſwered better, than by exhibiting the contraſt between thoſe who have water-meadows, and thoſe who have none, in the ſame diſtrict.

Every farmer who keeps a flock of ſheep, and particularly a breeding flock, in ſo cold and late-ſpringing a diſtrict as South Wilts, knows and feels the conſequences of the month of April. "That month, between hay and graſs, in which he who has not water-meadows for his ewes and lambs, frequently has nothing!" The ewes will bring a very good lamb with hay only; perhaps a few turnips are preſerved for the lambs, which in a very favourable ſeaſon may laſt them through March; but if they are then obliged to go to hay again, the ewes ſhrink their milk, the lambs "pitch and get ſtunted," and the beſt ſummer food will not recover them. To prevent this, recourſe is had to feeding the graſs of thoſe dry meadows that are intended for hay, the young

young clover, and frequently the young wheat; in fact, every thing that is green. And who will pretend to eſtimate the loſs that a farmer ſuffers by this expedient:

The ray graſs on the expoſed parts of this diſtrict is ſeldom "a bite" for the ſheep till near May-day. If the ſeaſon ſhould permit any turnips to be kept till that time, which can ſeldom be depended on, they are not only of little nouriſhment to the ſtock, but they exhauſt the land ſo as to prejudice the ſucceeding crop. And it ought to be remarked by the way, that in many parts of this diſtrict the ſoil is not at all favourable to the production of turnips. It therefore neceſſarily follows, that a farmer, under theſe circumſtances, has no certain reſource to ſupport his ſtock during theſe months, but hay; and even in that he is ſometimes diſappointed, by having been obliged in the preceding ſpring to feed all the land which he had laid up for a hay crop: he is then obliged to buy hay, and that frequently at the diſtance of many miles: and, to add to his diſtreſs at this critical time, his young ewes are then brought home from wintering to be kept nearly a month on hay alone.

In

In this month, which ſo often ruins the crops, and exhauſts the pockets of thoſe ſheep-breeding farmers who have no water meadows, the water-mead farmers may be truly ſaid to be "in clover." They train up their dry meadows early, ſo as almoſt to inſure a crop of hay; they get their turnips fed off in time to ſow barley, and have the vaſt advantage of a rich fold to manure it. They ſave a month's hay, and have no occaſion to touch their field graſs till there is a good bite for their ſheep; and their lambs are as forward at May-day, as thoſe of their leſs lucky neighbours are at Midſummer: and, after all, they are almoſt certain of a crop of hay on their water meadows, let their ſeaſon be what it will.

Management of Water Meadows.

The management of water meadows is in the following way:

As ſoon as the after graſs is eaten off as bare as can be, the manager of the mead, provincially the drowner, begins cleaning out the main drain, then the main carriage, and

and then proceeds to " right up the works ;" that is, to make good all the water carriages that the cattle have trodden down, and open all the drains they may have trodden in, ſo as to have one tier or pitch of work ready for drowning, and which is then put under water, if water is plenty enough, during the time the drowner is righting up the next pitch. In the flowing meadows this work is, or ought to be, done early enough in the autumn, to have the whole mead ready to catch, if poſſible, the firſt floods after Michaelmas, the water being then " thick and good ;" being the firſt waſhing of the arable lands on the ſides of the chalk hills, as well as of the dirt from the roads, &c. &c.

The length of this autumn watering cannot always be determined, as it depends on ſituations and circumſtances ; but if water can be commanded in plenty, the rule is to give it a " thorough good ſoaking" at firſt, perhaps a fortnight or three weeks, with a dry interval of a day or two; and ſometimes two fortnights, with a dry interval of a week; and then the works are made as dry as poſſible, to encourage the growth of the graſs. This firſt ſoaking is to make the land ſink and pitch cloſe together; a circumſtance

ſtance of great conſequence, not only to the quantity, but to the quality, of the graſs, and particularly to encourage the ſhooting of the new roots which the graſs is continually forming, to ſupport the forced growth above.

While the graſs grows freely, a freſh watering is not wanted; but as ſoon as it flags, the watering may be repeated for a few days at a time, whenever there is an opportunity of getting water, always keeping this fundamental rule in view, to make the meadows as dry as poſſible between every watering; and to ſtop the water the moment the appearance of any ſcum on the land, ſhews that it has already had water enough.

Some meadows that will bear the water three weeks in October, November, or December, will perhaps not bear it a week in February or March; and ſometimes ſcarcely two days in April or May.

In the catch meadows watered by ſprings, the great object is to keep the works of them as dry as poſſible between the intervals of watering; and as ſuch ſituations are ſeldom affected by floods, and generally have too little water, care is neceſſary to make the moſt of the water by catching and rouſing it as

as often as poſſible; and as the top works of every tier or pitch will be liable to get more of the water than thoſe lower down, care ſhould be taken to give the latter a longer time, ſo as to make them as equal as poſſible.

Cuſtom of feeding Meadows with Sheep.

It has already been ſaid that the great object, in this diſtrict, of an early crop of water-meadow graſs, is to enable the farmer to breed early lambs.

As ſoon as the lambs are able to travel with the ewes, perhaps about the middle of March, they begin to feed the water meadows. Care is or ought to be taken to make the meadows as dry as poſſible for ſome days before the ſheep are let in.

The graſs is hurdled out daily in portions, according to what the number of ſheep can eat in a day, to prevent their trampling the reſt; at the ſame time leaving a few open ſpaces in the hurdles for the lambs to get through, and feed forward in the freſh graſs.

One

One acre of good graſs will be ſufficient for five hundred couples for a day.

On account of the quickneſs of this graſs, it is not unuſual to allow the ewes and lambs to go into it with empty bellies, nor before the dew is off in a morning.

The cuſtomary hours of feeding are from ten or eleven o'clock in the morning to about four or five in the evening, when the ſheep are driven to fold; the fold being generally at that time of the year on the barley fallow: and the great object is to have water-mead graſs ſufficient for the ewes and lambs till the barley ſowing is ended.

Meadows laid up for Hay.

As ſoon as this firſt crop of graſs is eaten off by the ewes and lambs, the water is immediately thrown over the meadows, (at this time of the year two or three days over each pitch is generally ſufficient) and it is then made perfectly dry, and laid up for a hay crop. Six weeks are uſually ſufficient for the growth of the crop; it ſeldom requires eight: and there have been inſtances of great crops being produced in five.

Nature

Nature of Water-meadow Hay.

The hay of water meadows being frequently large and coarſe in its nature, it is neceſſary to cut it young; and if made well, it then becomes of a peculiarly nouriſhing, milky quality, either for ewes or dairy cows.

The water meadows are laid up for a ſecond crop in ſome inſtances, but this is only uſual when hay is ſcarce; not that it is ſuppoſed to hurt the land, but the hay is of that herbaceous, ſoft nature, and takes ſo long time in drying, that it is ſeldom well made. It is uſually of much greater value to be fed with dairy cows: and for that purpoſe a flaſh of after graſs, ſo early and ſo rank, will be preciſely of the ſame comparative ſervice to the dairy, as the ſpring feed has been deſcribed to be for ewes and lambs.

The cows remain in the meadows till the drowner begins to prepare for the winter watering.

Water Meadows ſafe for Sheep in Spring, but will rot them in Autumn.

Water meadows are reckoned to be perfectly ſafe for ſheep in the ſpring, even upon land that would rot ſheep if it was not watered; but in the autumn the beſt water meadows are ſuppoſed to be dangerous. This is at preſent an inexplicability in the operations of nature, and a diſcovery of the reaſon might lead perhaps, in ſome meaſure, to a diſcovery of the cauſes of the rot in ſheep *. But the circumſtance itſelf is rather an advantage than a diſadvantage to this diſtrict, as it obliges the farmers to keep a few dairy cows to feed the water meadows in autumn, and to provide artificial graſſes, or other green crops for their ſheep, during that period.

* See Paper, by the author of this book, on the diſorder in animals, termed Staggers, publiſhed in Dr. Anderſon's Agricultural Recreations, about June or July, 1799.

Proper Soil for Water Meadows.

From what has been ſo repeatedly urged on the neceſſity of making water meadows dry, as well as wet, every reader muſt have inferred the advantage of having them, if poſſible, on a warm abſorbent bottom *.

The bottom or ſub-ſoil of a water mead is of much more conſequence than the quality or the depth of the top ſoil. Not but that the land on peaty or clay bottoms may be conſiderably improved by watering; and there are many good water meadows on ſuch ſoils, but they are not ſo deſirable, on account of the difficulty of draining the water

* There is a ſtriking proof of the truth of this remark in the water meadows near Hungerford, and particularly at Standen. Although they are laid out in no regular plan, and in many inſtances there are no drains to empty the water carriages, yet the gravel bottom is ſo very abſorbent, that the water will ſoak out in a few hours, and the meadows be left as dry as if they were watered on the moſt ſyſtematic plan: few meadows in the country produce better crops, either of ſpring feed or of hay.

out

out of them, and making them firm enough to bear treading.

A looſe gravel, or what perhaps is ſtill better, a bed of broken flints, with little or no intermixture of earth, whenever it can be obtained, is the moſt deſirable bottom.

On many of the beſt water meadows in this diſtrict, where the bottom is a warm, abſorbent gravel, or rather a bed of broken flints, the ſoil is not quite ſix inches deep; and that depth is quite ſufficient, in thoſe ſeaſons when water is plenty, as the graſs will root in the warm gravel in preference to the beſt top ſoil whatever; and ſuch meadows always produce the earlieſt graſs in the ſpring. Nor is it ſo very material of what kind of graſſes the herbage is compoſed when the meadow is made: that kind will always predominate which agrees beſt with the ſoil and the water, provided the ſupply of water is regular and conſtant every winter; in other words, that kind will predominate which will bear wet and dry, and ſome of the worſt graſſes, in their native ſtate, will become the beſt when made ſucculent by plenty of water.

Uſe of Water Meadows.

The water meadows of Wiltſhire and the neighbouring counties are a branch of huſbandry that can never be too much recommended.

In ſpeaking of water meadows, it has been objected that they are local; and that there are many parts of the kingdom in which they neither can be made, nor are they neceſſary if they could be made.

There are undoubtedly, ſays the Communication to the Board, many parts of the kingdom in which water meadows cannot be made *; but nobody will deny but that there are thouſands of ſituations where they could be made, in which they have never been tried. And as for their uſe, it may be ſtrongly ſuſpected, that thoſe who deny it have never been in Wiltſhire in the month of April. Let thoſe who call it in queſtion point out a

* This book, however, goes to prove, that by means of art and machinery water meadows can be made any where! W. T.

ſubſtitute

ſubſtitute on which the farmer can, with equal certainty, depend for the ſuſtenance of his flock in that trying month.

Whatever may be the earlineſs of the ſeaſon, with reſpect to the ſpringing of either ray graſs or meadow graſs, water meadows will be a month before either.

And notwithſtanding the great advantages that have been derived from the introduction of green winter crops, ſuch as turnips, rape, cabbages, &c. (advantages to this kingdom almoſt beyond eſtimate) yet this may be laid down as a certain maxim, that whether the winter be hard or mild—whether the ſpring be late or early, nature will always have, in this climate, an "*interregnum*" between the end of one year's food and the beginning of another. The ſame temperature of the air in the ſpring, which brings on the graſs, will occaſion all green winter crops to run to ſeed, and not only to looſe their own nouriſhing quality, but to exhauſt the land on which they grow.

A moment's reflection will convince every man, that nature muſt unavoidably and conſtantly leave this chaſm in the year's food. Winter, though driven into a ſmall com-

paſs, is ſtill winter, and art alone can expunge it from the Kalendar.

Hot-houſes and hot-beds have, in a great meaſure, done this for the gardener. Water meadows, which are hot-beds for graſs, will as effectually do it for the farmer. How neceſſary is it, therefore, to impreſs the value of this branch of huſbandry on the minds of all the land-owners in the kingdom.

It is not only the moſt valuable, but the moſt permanent, of all improvements in huſbandry. It not only improves the land on which it is made, but makes all the adjoining land better by its produce; and it differs in one very material reſpect from all other improvements that a landlord can make for a tenant; that is to ſay, that time will even make it better, and that the careleſſneſs of a tenant cannot make it much worſe.

Before I take leave of the very intereſting examples of irrigation which this county affords, I think it proper to notice a very particular objection to the extenſion of ſuch canals as may be neceſſary to a complete watering; which, while it ariſes from the fear of deſtroying the ſources of agricultural irrigation on the one hand, ſhould operate with

with double force on the other, in favour of that combination of intereſts, which nothing leſs than a ſyſtem of national irrigation can give.

In page 156 of the Wiltſhire Report, it is ſtated that only one canal, viz. the Thames and Severn navigation, paſſes through that county. That ſeveral others have been propoſed, and that ſome are yet contemplated; "but the fear that canals will deprive the water meadows of water, makes many of the landholders averſe to them." If Government would ſtep forward with the primary means of general ſupply which is contemplated in my deſign, this, with a thouſand other objections which create an endleſs expence, and waſte much of the national time in Parliament, would for ever after vaniſh; and plenty and conveniency would be everywhere ſo prevalent, that the affections of the community might harmonize in ſuperabundance; and the diſquiet of party conteſts become loſt in the midſt of profuſion.

IRRIGATION OF THE COUNTY OF WORCESTER.

The great example of irrigation which compriſes the whole ſyſtem of this county, is ſaid to exiſt in the hands of one ſingle family. I ſhall therefore content myſelf with the account of it which has been tranſmitted to the Surveyor of that county, and by him to the Board of Agriculture.

The plan of watering the lands in this neighbourhood, belonging to the Foley family, is ſhortly as follows:

It is, in the firſt place, neceſſary to obſerve, that all the mills on the brook, or ſtream of water, as ſoon as it enters on their property, until it unites with the river Stour, for near three miles, belong to them; of courſe they have the control of the water. At the upper end of the ſtream are three or four water courſes, made for ſeveral miles upon a level to the different farms that are watered; and the whole ſtream is divided in a manner proportioned to the quantity of land each

each courſe is intended to water. The farms that receive this valuable acquiſition are eight or nine, and the quantity of land watered upon the whole of them is between three and four hundred acres. The quality of the ſoil, in general, is a very light ſand, and many parts of it mixed with gravel: by the diviſion of the ſtream as above, each farm has its portion of water repeated from two days to a week, every three weeks throughout the year; and in order to prevent the leaſt diſpute between the tenants, reſpecting the diſtribution of the water, a perſon is appointed to turn it from one perſon's land to the next in turn, at certain ſtated times fixed for this purpoſe.

The farmer then takes to the management of it, and floods ſuch parts of his lands as are generally prepared to receive it. There are very few of them that mow the whole of the land they water, but mow and graze it alternately, in ſuch a manner that they uſe the water at all ſeaſons of the year in their turn. A very conſiderable quantity of land in this neighbourhood is well ſituated to receive this improvement, if the ſtream was ſufficient for the purpoſe, beſides the number of acres already mentioned, the greater part of

of which was formerly a very poor arable land, and not worth more than five ſhillings an acre. The induſtrious farmers are very attentive to the uſe of water; all the gutters are cut for floating, with the uſe of a water level; and the more numerous the gutters are, the greater quantity of graſs the land produces.

In ſome ſituations, with the uſe of little ſtop gates, the gutters are cut deep enough to drain the land they are made to float: this circumſtance, where the land requires it, is worthy of great attention. The whole plan of irrigation, where practiſed (and very few farms indeed but what will admit of it in ſome degree), is, beyond a doubt the firſt and greateſt improvement, at the leaſt expence, ever diſcovered.

IRRIGATION IN DEVONSHIRE.

There are many inventions for irrigation in the county of Devon, and ſome of them (to the great honor and profit of proprietors) are carried into actual execution, on the encouragement of their own ſole reaſon, without example to guide their judgment; and on a ſcale which exhibits a ſpecimen to other countries, for the combination of commercial and agricultural advantages, in the items of agricultural irrigation, mill works, and canals.

Mr. Leach, a plain man, and ſurveyor by profeſſion, who ſtepped into the then little trodden path of a Treatiſe upon the Science of Inland Navigation, with ideas which would have done honor to an abler pen, ſo early as the year 1791, reduces his obſervation to nearly this ſummary maxim, that *where water is, there may navigation be alſo.* I ſhall be bold enough, before I have done with the ſubject, to ſtep one grade farther; for I dare pledge myſelf to ſhew, that there

there is not a tract of one mile ſquare in England into which canals may not be carried advantageouſly, if a proper national ſyſtem is adopted under a rule ſimilar to the Chineſe maxim, which is ſaid to compel the emperor himſelf to dig the firſt ſpade of earth out of his moſt favourite grounds, and to aſſure his people with an audible voice, that *no private pleaſure ſhall obſtruct the public good.*

But to return to Mr. Leach, he recommends an attention to combination in the following nervous and farmer-like language:

Agriculture, ſays he, is the moſt uſeful and ancient art of any whatſoever; and which moſt noble art, together with commerce, are the chief pillars and ſupport of theſe kingdoms. It is the duty of every one, who has any regard to his duty, to promote and encourage theſe uſeful arts; and there is no contrivance whatſoever that will go ſo far to this end as the conſtruction of inland navigation, and extending them into the interior of every part of the kingdom: a thing very poſſible to be done (ſays he) at any place where there is a river or ſtream of running water. For it may be affirmed as a fact, as it is confirmed to me by the clear-

eſt

eſt demonſtration, that there is hardly one ſtream or river of running water in the univerſe, where there is ſufficient water to work a common flour-mill, but it is capable of being made navigable.

In various parts of his work he dwells particularly on the agricultural advantages which are to be expected from the conveyance of manure, ſea-ſand, and other materials in huſbandry; but though it is probable that the ſurveys he was engaged on in Cornwall and Devon, may have contributed to ſtimulate enterpriſe, and expedite execution: one of the moſt intereſting inſtances of combined powers, in this way, ſeems to have reſulted from caſualty in the operations of James Templer, Eſq.; to whom we are indebted for new and valuable lights in the ſcience of *irrigation, by means of inland navigation.*

In the agricultural ſurvey of the County of Devon, which was made in the year 1794, by Mr. Fraſer, under directions from the Board of Agriculture, we are told that James Templer, Eſq. of Stover, in the County of Devon, has, in the way of communication by canals, and in turning them to advantage by watering the land adjacent, introduced

introduced a *principle* which is capable of wonderful extenſion.

This gentleman has by management in the diſtribution of water, from a canal communicating with the ſea at Teignmouth, united the *utile* and *dulce* with much propriety and effect; and which, at the ſame time that it reflects great honour on his genius, and muſt be productive of great perſonal emolument, has brought into light a principle of improvement not hitherto at all attended to; but properly conſidered, will ſhew that navigable canals may be rendered of advantage to agriculture, in a degree which is not thought of where they are confined merely to the purpoſes of conveying articles of commerce.

The water meadows belonging to James Templer, Eſq. above mentioned, are ſituated in the pariſh of Teigngrace; and are under management which is perhaps no where excelled.

The ſoil in moſt parts of this pariſh is a very poor thin black mould, on a ſtratum of cold clay, which is exported in great quantities for the uſe of the potteries in the neighbourhood of Liverpool, and other parts of the kingdom, forming a very conſiderable branch of

of traffic. This circumſtance induced Mr. Templer to form a navigable canal for the conveyance of this clay to Teignmouth, the port of ſhipping, without at firſt adverting to the uſe of ſuch a canal for the purpoſe of watering the land. His taſte for rural improvement ſoon made him perceive the advantages ariſing from this circumſtance.

A very conſiderable tract of marſhy land adjoining to the lower part of his canal, which did not produce above eight or ten ſhillings per acre, ſome not five, he drained and levelled. After which, by forming ſurface-conductors for the overplus water of the canal, and well-contrived ſluices, he diſtributed the water of the winter floods, enriched with the ſlime from the higher grounds, over theſe marſhes, now converted into verdant meadows. Theſe diſtributary ſluices are extremely ſimple and judicious in their conſtruction. They conſiſt of a number of trunks, placed at various diſtances, to each of which a plug is fitted. The trunks are placed above the level of the water neceſſary for navigating the canal; and when the floods fill the canal, theſe plugs are taken out, and the water is inſtantly diſtributed in a very beautiful manner

ner over the ſurface of the meadows; and is eaſily and ſpeedily ſtopped when it is conceived they have run long enough.

Mr. Templer has followed the ſame ſyſtem in the upper line of his canal, and with ſimilar ſucceſs. Theſe meadows he lets out for paſture grounds to his tenants; and it is curiöus to remark the great difficulty he had to perſuade them of the utility of this ſort of management. He was even obliged to bribe them to purſue their own advantage, by giving a remittance of part of their rent to thoſe who were moſt induſtrious in draining, and watching the opportunity of diſtributing the water in the floods: ſo very difficult is it to excite the generality of people to try new improvements! They are now, however, very ſenſible of the advantages ariſing from this ſyſtem, and are very glad to get an acre of meadow for 40s. and 3l. for which before they unwillingly paid 10s.

Another eſſential advantage produced by this canal, is the fine rich mud, mixed with rotten leaves of trees, &c. which is waſhed down by the rain, and depoſited in the canal. This, in ſummer time, is dragged out with long-tined harrows, by the aid of a couple of horſes or bullocks, and afterwards mixed with

with lime for the upper lands. This rich mud is a manure of itſelf, and he allows his tenants to take it freely for their own uſe.

In this manner he is accuſtoming his tenants to an induſtry which betters their own circumſtances, while, without laying out any conſiderable expence himſelf, his land is ſo rapidly increaſing in value, it is ſuppoſed it will in a few years equal the intereſt of the money laid out upon the canal, independent of the trade which is daily increaſing. A moſt wonderful effect is ſaid to be produced by laying ſea ſand on the meadows, which ſand forms a back carriage for the bargemen who carry the clay to Teignmouth. What renders theſe operations more intereſting, is, that theſe lands are in themſelves naturally ſo barren, that it was thought impoſſible to improve them; and Mr. Templer was the object almoſt of ridicule to his neighbours.

The advantages ariſing from the canal, and from his experiments, not only to him but to the neighbouring country, which will be more and more benefited, are now generally confeſſed; and if it ſhould be hereafter connected with any canals on the higher grounds of Dartmoor, the benefits ariſing

from it will be ſo widely extended, as to render it a vaſt advantage to the public.

In the further accounts of this agricultural ſurvey of the County of Devon, we find that the farmers ſouthwardly from Stover, appear to be every where ſenſible of the advantages of Mr. Templer's improvements, and every little ſtream is applied more or leſs to the watering of their grounds. They alſo catch the floods on the roads from the declivity of the hills, and convert them to this purpoſe.

So far the account of Mr. Templer's improvements which I have collected from the ſurvey above recited, as a ſtriking inſtance of *what* may be done!—But, as I purpoſe to go farther, with a view of certain places where *much* may be done, I beg leave to notice a few particulars touching the Foreſt of Dartmoor as an example, which being chiefly the property of his Royal Highneſs the Prince of Wales, is in hands competent to great undertakings, where he may deem them to be deſigns which may benefit his country.

Mr. Fraſer deſcribes the weſtern diſtrict of the County of Devon to be only patches in cultivation. By far the greateſt part, ſays he, conſiſts of undivided waſtes and commons,

mons, amounting to between 2 and 300,000 acres of land, if not more than that quantity.

In the center of theſe waſtes is ſituated the Foreſt of Dartmoor, the property of his Royal Highneſs the Prince of Wales.

This foreſt is the higheſt part of the diſtrict. In the north part of this foreſt, and the higheſt grounds, the ſoil conſiſts of extenſive tracts of a wet turf or peat of a great depth; in other parts of a light black ſoil or gravelly, intermixed with a yellowiſh or whitiſh clay. Declining from the foreſt in other parts of the diſtrict, it partakes more or leſs of ſimilar qualities; chiefly light black peaty earth or gravelly. Many of the vales both on the foreſt, and in other parts of the diſtrict, appear very capable of improvement; and the whole, if ſtocked by cattle and ſheep, capable of being made the ſource of additional wealth to the kingdom.

The mountains of Dartmoor form the grand reſervoir, from whence water is plentifully diſtributed to all parts of the county.

The waters, which empty into St. George's Channel on the one hand, and Briſtol Channel on the other, are ſaid to riſe within three quarters of a mile of each other; and their

ſources are computed to be not more than between eight and nine hundred feet above the level of the ſea; and yet except ſome of the *tors*, this ſummit is higher than any other part of Dartmoor; ſo that the height of this country is by no means ſo formidable as it appears to the eye of common obſervation.

Deſcending from this ſummit there is an immenſe extent of mountainous land, thro' which there are vallies and levels to be found, by which canals might be extended on a level for miles together.

The concluſion to be inferred from theſe premiſes is certainly founded in truth, when it is ſuppoſed that water cannot be more economically uſed, or to greater advantage, than in improving ſuch tracts of waſte lands as thoſe about Dartmoor, by means of canals and ducts for the purpoſe of manuring and irrigating them; and that this is practicable in various productive ways, adjuſted to the circumſtances of theſe or other particular premiſes, upon general principles which will apply every where, I flatter myſelf I ſhall be able to demonſtrate in the ulterior relations of this book. By the means I ſhall propoſe, canals may be eaſily extended into all parts of

of this waſte, and communicated thence to the ſea by Mr. Templer's canal and other routes, by which lime, coals, ſea ſand, with other manures, &c. could be conveyed to this waſte, and the granite, tin, copper, &c. with which it abounds, would form a trade in return. The reſult of theſe operations would be, that agriculture which, to the ſurpriſe of ſtrangers, has proceeded ſo ſhort a way from the ſea coaſts, would penetrate to the centre of Dartmoor, and the brown heath would ſoon become changed to a verdant green. Inſtead of miſerable half-ſtarved ſheep, which are permitted to wander over theſe wilds without the foſtering hand of a ſhepherd, regular flocks would be conducted with ſkill and care, and give an additional ſource of wealth to the community. By facilitating the carriage, even by ſmall canals, the expence of manure would be reduced; whereby the farmer might improve more land than he could manage otherwiſe, add beauty to his tenement, and value to the eſtate of his landlord.

In proportion to the extenſion of canals, the number of horſes and mules employed as carriers will always be reduced; and as provender is thereby ſaved in this item, pro-

viſions will become more abundant in another, by the increaſe of oxen and ſheep.

To uſe the words of my friend Mr. Fulton, (which it is difficult to avoid, ſeeing we have for ſeveral years thought and written with little variation from the ſame expreſſions, while at the diſtance of three thouſand miles apart, and then without knowledge of each other)—Is it not intereſting on this point to ſee the diſparity between land and water carriage: in Cornwall a mule uſually carries three hundred pounds weight, (and even in this way is Dartmoor ſaid to be manured,) while upon a ſmall canal, the conſtruction whereof I apprehend would not exceed three hundred pounds per mile, throughout the kingdom in nett expence, one mule will convey twenty tons with eaſe: hence one mule performs the ordinary work of one hundred and thirty, and the greater part of mules and horſes might thus go to cheapen the impetus of neck-breaking pleaſures, to lighten the burthens of manual labour, or the better purpoſes of that ruſtic implement the plough, which gives ſuch wonderful effect towards the multiplication of our ſpecies, and the production of domeſtic plenty.

The

The invention of the ſteam-engine has been conſidered as a contrivance of the firſt importance to mankind; becauſe of its immenſely increaſed capacity in ſaving animal labour, and reducing the burthenſome expence of employing and feeding, as formerly, ſuch numbers as were then neceſſary to give rotary motion to an infinity of machinery.

Thoſe improvements of this engine which contribute to ſave coal, have been viewed as a material conſideration in the mining intereſt; and canals, which have reduced the expence of carriage in much greater ratio than the grades of power between man and horſe, or between horſe and waggon, muſt, with their powerful influence in irrigation, neceſſarily militate to cheapen the price, and multiply the ſupply of human comforts.

If the tradeſmen of the ſeveral towns are enabled to procure heavy articles at a reduced carriage, their cuſtomers all feel the benefit of a proportionate price, which nevertheleſs ſecures equally a fair profit to the vendor. If coals are thus reduced in their carriage, or new mines become thus opened to market, the cottager is enabled to burn more of them; and numerous bleſſings are the offſpring of a comfortable l earth.

The ſame mode of reaſoning applies to every ſpecies of purſuit which requires the transfer of heavy articles; and regardleſs of the ſcience of irrigation, to the aid whereof canals may be ſo conſtructed as to afford inexhauſtible reſources, there is no point in which they can be viewed but they exhibit ineſtimable advantages to the bulk of ſociety; becauſe every amendment which reduces the quantity of animal labour, or which yields a greater abundance with the ſame manual applications, muſt render the accommodations of life more plentiful, cheap, and diſtributive.

When two perſons, for example, are preſent at the common mart of traffic, with any quid pro quo of commerce which they incline to exchange, the barter will meet upon equal terms, and each will obtain a reaſonable proportion of the ſurplus commodity of the other; but, if one perſon has his produce upon the ſpot, and the other brings the article wanted a mile, the expence of that mile's carriage will neceſſarily reduce the quantity thereof to be given, upon the ſame principles of fair trading, in proportion to the coſt of one mile's conveyance.

In the ſame way every additional mile's carriage

carriage muſt make a proportionate reduction of the quantity of the transferred articles to be delivered; even to the prohibition of intercourſe, unleſs the inland party ſubmits to the impoſitions of neceſſity. Now at the ſame rates for animal conveyance, apart from attendance, there can be no material difference whether one hundred and thirty mules go one mile to bring each a ſack of corn, or whether one mule goes one mile one hundred and thirty times over, to perform the ſame quantity of carriage. But if, by the conſtruction of a canal of one mile in length, with the price of one hundred and twenty-nine mules, the remaining one is enabled to perform the ſame transfer, he thereby ſaves to the community the feeding, attendance, and equipments of one hundred and twenty-nine mules per day, and the charge for conveyance of merchandize will be proportionably leſſened; although thoſe perſons who are employed as carriers will receive the ſame degree of fair profit, as if no canal had been conſtructed, and yield to the community a multiplied reſult.

If we farther view the extenſion of inland canals, in reſpect to the various purpoſes of agricultural improvement for which they are capacitated,

capacitated, the mind muſt contemplate with ſurpriſe the wonderful proſpect of multiplied reſources which will proceed from the moſt ſteril and mooriſh parts of the kingdom; and which Mr. Templer's actual improvements have demonſtrated ſound data, to expect. The mining countries perhaps might produce corn and fleſh in ſufficient quantities for their home conſumption; and the balance of traffic would remain as an annual accumulation to penetrate farther into the earth, or to enrich and beautify its ſurface.

If the extenſion of canals can facilitate and cheapen the expence of manure, we may behold every little farmer in a condition to improve a greater quantity of ſoil; to poliſh the eſtate he poſſeſſes to the enrichment of his landlord; and to contribute additional benefits to the weal of ſociety. The features of content would thus diſpel the gloom of abject wretchedneſs from his brow; and he would behold that manlineſs of antient days in his growing offspring, which can alone contribute permanent ſafety and proſperity to his country.

In viewing canals as agents to agriculture, we ſhould not forget the innumerable advantages which have reſulted from the uſe of

ſea

ſea land, when it admits of carriage to the interior parts of the kingdom; and if the lands are ſuppoſed to receive melioration from the carbonic acid, or from any particular ſolid quality contained in that or the ſhells it is mixed with, it may merit conſideration whether croſs cuts are not practicable in moſt parts of the kingdom, which would juſtify an actual extenſion upon the ſole principle of this ſpecies of huſbandry, independent of other purpoſes. But if it is ſimply the ſaline that is required, it may prove no difficult matter to form reſervoirs upon the ſeveral eminences which overtop the reſpective neighbourhoods, by extending pipes in the nature of water-works, as an undertaking of Government, which being properly ſyſtemized, may accommodate agriculture in the remoteſt parts, and form ſalt-water baths in the city of London, or extend them into every pariſh in the kingdom, and ornament the pleaſure grounds of thoſe who may prefer ſuch, with caſcades and fountains of a ſpecies which no other country exhibits.

There are ſome other conſiderations in favour of agricultural canals, which ſhould not be omitted.

By

By land carriage it is abſolutely impoſſible to perform a ſufficient transfer of manure, to gain any conſiderable advantage of time and quantity during the continuance of a ſeaſon; but by agricultural canals the quantity may be multiplied, the price reduced, and the ſeaſon extended to a ſpacious tract of farm.

This increaſe of improvement will remunerate its accumulation with manifold force. The quantity of articles carried upon a canal will enable conveyance at leſs expence; or the ſurplus monies may be applied to the diſtribution of more minute bleſſings, into the ſmaller arteries of irrigation.

To facilitate and expedite theſe great ends, it would be a deſirable attainment to effect ſome more cheap and ſimple method of raiſing a ſupply of water equal to the undertaking, from the lower reſources of lakes, rivers, and the tides; for the conſtruction, wear, and tear of the ſteam engine, and other expenſive machinery, together with their contingent charges, are a conſiderable drawback on the advantages of an agricultural uſe of water. I have endeavoured to contribute my mite to this kind of improvement in the following pages: I ſubmit them

to

to the public, in hopes that they may ſtimulate ſome more able genius to add his thoughts on this intereſting particular.

A Deſign for obtaining a Mechanical Power from the mere Motion of the Waters; and for diſtributing that Power into every Part of Great Britain, ſo that the Supply may be rendered equal to any given Demand which may be required.

Mr. Ferguſon defines a fluid to be "a body that yields to the leaſt preſſure, or difference of preſſures."—"Its particles," he ſays, "are hard, ſince no fluid, except air or ſteam, can be preſſed into a leſs ſpace than it naturally poſſeſſes."

It appears to me, that from theſe properties we may deduce ſufficient principles to juſtify an experiment upon the mere motion of the ſea; for there ſeems to be no doubt that the force by which the flowing tide is impelled, does at all times yield a difference of preſſure, of ſufficient importance to overcome the reſiſtance which may be impeded by an equal fluid in a ſtate of reſt: for as each

each particle is equally free to move, it will always move towards that point where there is the leaſt preſſure, and recede from that where there is the moſt.

Let an air veſſel, for example, be conſtructed with a valve near its bottom, and a main pipe aſcending from its ſide: let it then be filled up with water; then fill a common ſyringe with water, and inject it through the tube which contains the valve: I apprehend there can be little doubt that the water contained in the veſſel will riſe in the main pipe in proportion to the quantity injected; becauſe of the force applied to the ſyringe, which affords a difference of preſſure upon particles otherwiſe equal. Upon a ſimilar principle a wedge is made to cleave the ſame tree, or enter the ſame timber of which it is formed, by means of the ſtroke or preſſure applied.

There is a copying machine invented, by Mr. Bramah, which acts by means of a very ſmall forcing pump. This injects water into a cylinder, ſo as to move a piſton and table upwards. I am told that the power of this little contrivance is ſo great, as to preſs a block of wood to pieces which is ſix inches

inches ſquare: I have not ſeen this experiment.

Mr. Foulds, at the London-bridge water-works, has approached ſtill nearer to my idea, by combining the properties of fluid matter through the help of an air veſſel; thus availing himſelf of elaſticity, for the purpoſe of filling the mains of the London-bridge water-works, which were formerly ſupplied by means of an elevated tower, conſtructed on the ſimple fountain principle; into this the water was raiſed by the ſame forcing pumps which are now applied to the air veſſel; and was from thence diſtributed from the tower into the mains of the water-works.

The chief difference between Mr. Foulds's method and my conjecture is, that I ſuppoſe the motion of the tide, when governed by a proper direction, will be fully competent to open the valves of an air veſſel; by which means the water will be injected and raiſed into the mains by the elaſtic action of the compreſſed air upon its ſurface, as in the caſe of the London water-works, without the force of any additional power.

I do not pretend to form an obſtinate concluſion, that this is the only method that will

will anſwer; that this is complete in itſelf without amendment or aid; that this is either without objections to it, or am I certain that it will anſwer at all. It ſtrikes me as a deſign worthy of experiment, although I perceive ſome difficulties to be overcome; ſuch as the ſiltage of the ſand which the ſea brings with it: this may happen to choke the valves, or fill up the air veſſel and ducts: it may be requiſite to contrive ſucceſſive valves to meet the riſe of the tide, and to ſhut each other by means of a click or ſpring: there is alſo a neceſſity to bring the fluid into a ſtate of equilibrium within and without the air veſſel, before the valve will open at all; and to this muſt be added the motion of the ſea, from whence the difference of preſſure or preponderance is to be expected. Succeſſive lights, however, will ariſe from an inveſtigation of the ſubject; and I am induced to hope that theſe would amply reward the inquiry.

It may perhaps be ſtill farther neceſſary to add ſome ſmall power by means of machinery, to help the action of the air veſſel; but if even this ſucceeds, it will be an ineſtimable acquiſition to agriculture, manufactures, and commerce: for I have no heſitation

tion in ſaying, that the preſent ſyſtem of practical hydraulics is, in many things, imperfect, partial, and puerile; and that it may be amended in the items of inland navigation, irrigation, and drainage, as well as in reſpect to mechanical application, and the watering of towns and cities. I will even add, that if the whole of the demand for irrigating the kingdom entirely through every part of it is to be ſupplied, by machinery, from the lakes of Cumberland, &c. or from the flow of the tide, and by the total application of machinery, that the Government may draw a powerful revenue from ſuch a national operation; and the country would be enriched by it, to the advantage of all its inhabitants.

This poſition applies equally to Scotland and to Ireland; and, indeed, to every other country; for all countries have what is termed a back bone, land's height, or higheſt point or ridge of elevation between the waters which diſcharge themſelves one way, and thoſe which run in another direction: yet ſo attentive are mankind to individual intereſts, and ſo limited have been the mere local operation of civil engineers, that the ſavings of wealth which a combination of

he very powers that have been ſeparately applied would have produced, ſeems to be a ſubject which has not occurred to them. But it is nevertheleſs a topic which admits of ample demonſtration; and of eſtimates, founded on experience, which may be made to approximate nearly to a practical reſult.

Suppoſe, for example, that Government were to take into their own hands the conſtruction of *one grand national water-work*, for the purpoſe of elevating a ſufficient ſupply of freſh and ſalt water from the moſt convenient waters below, to the moſt elevated hills, mountains, and peaks; forming ſpacious reſervoirs in the coves or theſe ſteril regions; and that a grand communication, by mains, pipes, and canals, was formed from one hill or eminence to another throughout all the dividing ridges which ſeparate the principal waters and rivers of the kingdom. There could, in this caſe, be no doubt remaining, upon principles long proved by practice, that from baſins or reſervoirs erected near theſe ſummits, water would diſtribute itſelf afterwards by the mere act of its own gravity, duly regiſtered or governed by air tubes, into every acre in the iſland; and from thence diſcharge its ſurplus

to

to the ſea, through the ordinary ſewers which nature has deſigned.

This capacity being thus once obtained, the ſupply would be always regulated and juſtified by the extent of the demand; and, from hence, all the ſmaller drains of private navigation, culinary purpoſes, irrigation, and manufactures, might be furniſhed at a moderate rent. This would complete an ineſtimable ſyſtem of public economy, mutually redounding to the benefit of the crown and the ſubject, and highly honorable to Britiſh ſcience, and to this age of ſuperior improvement.

If we wiſh, however, to be moreover ſatisfied in regard to the pecuniary advantages which may be made to flow from this medium of public economy, we are furniſhed with accurate data for an eſtimate which may approach near enough to our purpoſe to form a ſatisfactory fiſcal calculation. The heights of the principal hills and mountains in England are as follow:

	Feet.
Skiddaw, in Cumberland, is above Broad Water — - —	3300
Axe-Edge Peak, in Derbyſhire, is above Derby — —	2100
Bunſter Hill, in Staffordſhire, is above Trent — — —	1200
Exton Hill, above the level of the Dove — — —	700
And Dartmoor, above the ſea, about	1000
Making in all theſe ſummits - -	8300
The mean elevation being - -	1650

The point of partage of the Grand Trunk Canal, which traverſes the heart of the kingdom, through the county of Stafford, in its way from Liverpool to Hull, has a riſe of 316 feet, and a fall of 326 feet, yielding a mean elevation of 321 feet, which may, I think, be fairly taken as the medium partage between the rivers of England that empty into the Britiſh ocean, and thoſe which diſembogue themſelves into the Iriſh ſea.

By

By an admeaſurement upon Mr. Cary's large map, I find that a main trunk or canal, of ſix hundred miles in length, would be ſufficient to extend a ſupply of water throughout the kingdom, from the boundary of Scotland to the Land's end, along the dividing ridge, or moſt elevated land in the country; from whence its own gravitation would convey it everywhere elſe, through the pipes and canals of individuals, or of aſſociated companies: but, to render the diſtribution more complete through every part of the kingdom, I will add nine hundred miles more as an allowance for public branches along the principal dividing heights, and take a greater number of elevations into the account, ſo as to eſtimate the national diſtribution of water to be a main of fifteen hundred miles extent, having its reſervoirs elevated at the average riſe of 900 feet; which is nearly a mean between the mountain ſummits, and the partage of the Grand Trunk Canal.

Thus, I preſume, every objection will be removed in reſpect to the principle; which, like that whereby the human body is ſupplied from the grand reſervoir of the heart into the ſmalleſt arteries of the head, the

fingers, and the toes, would diſtribute its bounteous influence into the moſt diſtant canal, into every mill-pond which ſhould be deſired, into every farm and garden which ſhould be cultivated, into every tan yard which requires it, into every bath, caſcade, and fiſhpond of luxury; into every fountain of ornament or uſe which might be deſirable; into every houſe which ſhould be inhabited; into every kitchen which ſhould cook a dinner; and into every water cloſet which ſhould accommodate the remaining occaſions of the family.

But it is a misfortune which I have often obſerved, that men are prone to confound a principle, from which you calculate with a deſign to incur the whole expence. Now, as I admit a very material diſtinction between what is theoretically poſſible, and that which is practically expedient, I think it proper to premiſe an explanation before I attempt an eſtimate. I would have it underſtood, that it is my opinion that all elevated countries, which neglect to conſtruct an elevated navigation, are purſuing a defective ſyſtem of canal conveyance: a ſyſtem which bids fairly to exhauſt the natural ſupply of water, to

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ſilt up the natural ſewers of the country, to injure the depths of river navigation, to create ill blood and ſtrife between party and party, and to terminate in a thouſand diſappointments, becauſe there are not ſprings enough for every man.

Hence it is that I would have the *nation* to begin at the right end of the buſineſs, by obtaining a command of water which ſhould be competent to all its occaſions; and I will endeavour to make a ſufficient eſtimate, to ſhew the nature of the expence and profit which I contemplate; but I would not have it from thence inferred that I would expect a prompt execution of the deſign: it is ſufficient to lay out the plan, and carry into effect ſuch parts of it as may be found progreſſively convenient; for whether ſuch a deſign has a capacity for completion in five years, or five hundred years, is a matter reſting wholly upon contingencies, and muſt greatly depend on its points of remuneration. It ſhould be nevertheleſs remembered, that every great national undertaking has its beginning; and it is certainly highly honorable to the reign which commences ſuch works of bounty and munificence.

It would be adviſable in an undertaking of this nature, that if the coſt of machinery cannot be done away by the ſubſtitution of ſome ſuch invention as I have endeavoured to contrive an application of to the mere motion of the ſea, that the expence ſhould be reduced ſo far as it may be found practicable, by the adoption of co-operative powers. The horizontal wind-mill is one which may be applied to great advantage in all windy ſituations; for it matters not in what direction the wind comes, or that it is attended; yet it will always be found a ſelf-acting machine, whenſoever the wind blows at any point: and by this means a conſiderable quantity of water may be alſo forced into the air-veſſel, independent of the action of the tide.

Indeed I think it will not be very difficult to contrive a helping machine to the motion of the valves, which it is neceſſary to govern with mathematical nicety.

By the help of ſurface-conductors the rain may be collected from the mountain tops into the various reſervoirs which hilly countries generally admit of in cheap and ſterile ſituations, to a very conſiderable extent; into theſe, according to their various levels,

levels, many little ſtreams of water may be directed; and numerous inſtances will occur, where the aſſiſtance of the cheap lifting-wheel, which I have herein before deſcribed, will re-elevate the overflow to baſins on a higher eminence; from whence it may be again diſtributed in droughthy ſeaſons. There is, under contemplation of this little branch of economy, one circumſtance to which I beg leave to call the attention of every man who manages a farm. The cheapneſs of this laſt machine brings it within every farmer's reach; and if he will only be at the pains to uſe it, during the time for manuring his graſs lands, for the purpoſe of mixing liquid manure in a pit properly ſituated for diſtributing ſuch into ſurface-drains through his grounds, he will find himſelf wonderfully rewarded by an abundant crop of graſs, of the richeſt quality, even progreſſively from the barren heath.

But when we are eſtimating a deſign in order to determine its expediency, it will always be found ſafeſt to allow the moſt expenſive methods; which will not only enſure leſs diſappointment in any caſe, but will alſo leave more room to ſpirit up the execution

tion by the ſucceſſive amendments which may occur.

I ſhall therefore make the actual practice, in water-works moved by the power of ſteam, the baſis of my calculations; and if I ſhould fortunately ſucceed in any new method or improvement, by which a national ſaving ſhall be attained, I truſt I ſhall at leaſt reap the credit of it, although thoſe who have the benefit of a more fortunate patronage may be more likely to enjoy its pecuniary advantages.

Of the Power and Expence of conſtructing a National Irrigation; and of communicating a Regulating Main throughout the Kingdom of England, to be fed wholly from the lower Level of the Tide, Lakes, and Rivers, by Means of Machinery.

In purſuing this inquiry I ſhall adopt the principle of ſafety which I have juſt laid down, and ſhall found my calculations on the moſt expenſive machinery.

In my Political Economy of Inland Navigation, Irrigation, and Drainage, publiſhed laſt

laſt year by Mr. Faulder, in Bond-ſtreet, in calculating the power and expence demanded in my plan for inſulating the city of London by means of a navigable canal, I have taken the actual practice of the ſteam engine which is employed daily in the Shadwell water works as my datum; and I have, in that work, gone into many detail conſiderations and eſtimates which may be eaſily referred to, and which it would be, therefore, ſuperfluous to repeat.

By this engine the water is raiſed ninety feet; its pump-barrel is twelve inches; and twenty-two ſtrokes, of ſix feet each, are performed in one minute.

The coſt of this engine is eſtimated at two thouſand pounds; and its conſumption of coals at two buſhels per hour.

Now as I have fixed the mean perpendicular height of the propoſed national reſervoirs at nine hundred feet elevation above the lower level, I will firſt endeavour to calculate the expence of commanding ſo much water at pleaſure, for the ſupport of a regulating main; and of diſtributing its influence, from the reſervoirs, through every part of the kingdom.

As the ſurpluſage of one ſuch main, confined

fined merely to the demands of irrigation, when the drought of the ſeaſon may happen to exhauſt the due proportion of humidity, would probably be of ſufficient importance in itſelf; and more particularly as any greater demand for canals, factories, mills, fiſh-ponds, caſcades, pleaſure fountains, &c. will carry with it an increaſe of income to the water works, from whence they will neceſſarily draw an accumulated profit ſufficient to juſtify additional pipes: it will ſuffice that we take this limitation of the ſubject as an ample baſis for every further extent of it.

It ſhould be held as an invariable rule in the general practice of raiſing water, or boats, in hydraulic operations, that where the riſe or fall can be brought to one ſingle riſe or fall of the land which divides the higher and lower levels of a country, the work for doing this ſhould never be divided; for it is plain that every repetition of ſuch a transfer muſt repeat a great proportion of the machinery or lockage as often as the operation is to be repeated; beſides the increaſe of attendants, and delays of repeating proceſs. In theoretic calculations it is, however, of ſome importance, for the reaſons

before

before aſſigned, to eſtimate repeated, perhaps unneceſſary operations.

Hence, as Shadwell engine raiſes its water ninety feet, at a known expence, I will allow ten ſuch engines to reach nine hundred feet elevation in the propoſed national water works; and one grand reſervoir, beſides a ſet of regulating baſins, to equal each twenty-five miles of main, throughout the fifteen hundred miles that I have propoſed the extenſion of national mains, from Scotland to Cornwall.

Of the Expence.

According to the foregoing premiſes it will be perceived, that ſix hundred ſteam engines, of the value of one million two hundred thouſand pounds, conſuming two buſhels of coals each per hour, amounting to four thouſand eight hundred and ſixty-ſix and two-thirds chaldrons of coals for each ten engines; or two hundred and fifty-two thouſand chaldrons, per annum, for the whole kingdom will be demanded; which, at the good average price of forty ſhillings per chaldron, would be five hundred and four thouſand pounds for fuel.

There

There will be a demand of eighteen thouſand yards of elevating main, to raiſe the water from the lower level to ſixty grand reſervoirs, each nine hundred feet above that level; this item, ſay, at two hundred weight of caſt iron to each yard of twelve inch pipe, and five-eight metal, (which will eaſily bear a hundred feet column of water), amounts, at fourteen ſhillings per hundred weight, to the ſum of twenty-five thouſand two hundred pounds.

Wooden pipes, cartage, laying down, extra charges, &c. incluſive, for fifteen hundred miles of regulating main, at twenty ſhillings per yard, will amount to two million ſix hundred and forty thouſand pounds. Say for ſixty grand reſervoirs, at two thouſand pounds each, one hundred and twenty thouſand pounds; and one hundred thouſand more for regulating baſins, buildings, &c.

Thus the aggregate coſt of conſtruction may be ſtated as follows:

600 Steam

600 Steam engines, each 2000l.	£.1,200,000
1800 Yards of elevating main -	25,000
1500 Miles of regulating mains	2,640,000
60 Grand reſervoirs, each 2000l.	120,000
Regulating baiſins - -	100,000
Allow largely for contingencies	915,000
Total coſt,	£.5,000,000

It follows to ſtate the intereſt for which this ſum may be obtained on ſo eligible a ſecurity; and to add the yearly charges which are attached, before the probable ballance of national gain can be aſcertained or remunerated: and, as the government are all competent to regulate the rate of intereſt, I will ſuppoſe the ſum of ten per cent. per annum to be ſufficient inducement. Hence the following will be approximate to

The annual expence,

Loan of five millions, obtained at ten per cent. intereſt -	£.500,000
Carried forward,	£.500,000

Amount

Amount brought forward -	£.500,000
Conſumption of 250,000 chaldrons of coals, at 40s. per chaldron - - - - -	504,000
500 Superintendants of different deſcriptions, averaging 200l. incluſive - - - -	100,000
Wear and tear, diſappointments, caſualties, new works, and contingencies - - -	396,000
Total of annual charges,	£.1,500,000

This annual expence will, I apprehend, be ſufficiently powerful to govern the temperature of the ſeaſons, and to direct elementary bleſſings into the coffers of the kingdom, if it ſhould be thought proper to execute the work for public account and riſque, by means of monies to be loaned on the faith of this great improvement. I will next endeavour to illuſtrate this lucrative proſpect, by opinions and facts of the higheſt authority; and which muſt greatly overbalance the weight of my own arguments in the ſcale of popular conviction.

Of

Of certain Advantages which may accrue to the Government, and to its Subjects, from the Conſtruction of grand National Water Works, as herein propoſed; and from thus irrigating the ſteril Lands of the Kingdom by the ſame Means which ſupply our commercial and culinary Purpoſes.

Several of the principles which I have conceived to be moſt applicable and efficient towards producing the ineſtimable ends which we are looking to, were hinted at in my laſt year's plan for inſulating the City of London, and beſtowing all the appendant advantages of a navigable canal upon the metropolis and the ſurrounding country; and the theory and practice of hydraulic operations were ſtill more enlarged upon in my general work, The Political Economy of Inland Navigation, Irrigation, and Drainage.

As I am at preſent, however, to aim at convincing ſociety that my deſigns are practicable, I preſume the facts which exiſt in other countries, or which are entitled to faith in this, upon the reſpectable ſtate-

ments and opinions of ſuch men as Arthur Young, Eſq. Sir John Sinclair, and Mr. Middleton, will be received as admiſſible evidence in the cauſe of approximate conviction.

It is known to the world, that Mr. Young, now Secretary to the Board of Agriculture in London, made a tour of agricultural obſervation through France in the years 1787, 1788, and 1789. That tour was publiſhed in London in 1792; and I have now the pleaſure of appealing to the intereſting teſtimony it affords me on the capacities of irrigation. I do this with more heartfelt pleaſure, in as much as theſe improvements apply with intereſting propriety to many impoveriſhed ſoils in my native county of Cumberland, and the country adjacent: indeed it is a very natural inclination for men to be zealous for the proſperity of their natal ſpot, and I heartily join the Biſhop of Landaff in fervent prayer, *"that while there is an acre of ſuch waſte improvable land in Great Britain, no inhabitant of this iſland may be driven by diſtreſs," or by the inhoſpitable

* The Biſhop's preliminary obſervations to the Agricultural Report of Weſtmoreland.

perſecutions

perſecutions of his relatives, "to ſeek a ſubſiſtence in Africa or America!"

Mr. Young ſays *, at Perpignan, the richeſt arable of the vale at Pia, ſells, if not watered, at 600 liv. the minatre, (20l. 9s. 6d. per acre); but the watered lands at 1000 liv. (37l. 9s. 10d. per acre). † At Campan, lands, with water at command, ſell at 600 liv. the journal (49l. 17s. 6d. per acre), of 700 cannes, (about 19,600 feet); but not watered, from 300 to 400 liv.

At Falaiſe, this ſame author informs us of ‡ a vale of watered meadows that produce 100 liv. per acre, 22 feet to the perch, (3l. 10s.)

At Montelimart, he ſays §, cloſe to the town, a ſeptier, which is one-half of an arpent of Paris, let sat $2\frac{1}{2}$ louis d'ors, or five the arpent, 120 liv. (6l. 2s. 6d. per acre.) At a diſtance 60 liv. with obligation to dung every ſecond year, which is remarkable: 100 ſeptrees; that receive the waſhings of the city, lets at 5000 liv.; beſides 600 liv. for the winter feed of ſheep.

At Avignon, he tells us, irrigation is car-

* Young's Tour to France, p. 363.
† Ibid. p. 364. ‡ Ibid. p. 364. § Ib. 365.

ried on in great perfection, by means of the waters of the river Durance, and the Crillon Canal, made only for the purpoſes of watering. The meadows are mown thrice a year, producing from 30 quintals of hay, at 40 to 60 the quintal, on each eymena of 21,600 feet, (7 ton 14 cwt. per acre), at three cuts. Such meadows ſell, near the town, at 1000 liv. (76l. 10s. per acre); further from it, 800 liv. (61l. 5s. per acre).

In page 368, this Gentleman adds, in relation to irrigation: "It appears, that in ſome parts of France, particularly in the ſouthern provinces, this part of rural economy is well underſtood and largely practiſed; but the moſt capital exertions are very much confined: I met with them only in Provence, and the weſtern mountainous parts of Languedoc. In the former canals are cut, at the expence of the province, for conducting water many miles in order to irrigate barren tracts of land: in England we have no idea of ſuch a thing. The intereſts of commerce will induce our legiſlature to cut through private properties, but never the intereſts of cultivation."

Again, ſays Mr. Young, * The diffe-

* Young's Tour through France, p. 369.

rence

rence in value between cultivation, watered or not watered, is not greater there than here, except on arid and abſolutely barren lands, on which the difference ariſing from climate is certainly enormous. Under a hot ſun, and in a comparatively dry climate, like that of Provence, ſandy or ſtony tracks, ſuch as La Crau, yield, comparatively ſpeaking, nothing; but watered, they become clothed with the richeſt verdure, and yield the fineſt crops. In regarding, therefore, the latitude of a country as an index for aſcertaining the degree of improvement effected by irrigation, theory would deceive us greatly. Water gives many other things beſides humidity; it manures, conſolidates, deepens the ſtaple or ſurface mould, and guards againſt cold; effects as obvious in a northern as in a ſouthern climate. He concludes this ſubject by recommending this moſt obvious and important object, as one of the firſt in the circle of rural economics.

Sir John Sinclair, in urging this ſubject to the attention of the members of the Board of Agriculture, of which he was then Preſident, ſays, (I preſume without contemplating any general deſign, like mine, for

raiſing water), *"at leaſt a million of acres of the waſte lands of the kingdom may certainly be brought to an aſtoniſhing height of cultivation by watering or irrigation. This great means of improvement, though long eſtabliſhed in ſome parts of the kingdom, yet in others has been unaccountably neglected. But when once that art is extended as it deſerves, the advantages to be derived cannot be eaſily calculated; for by it land is not only rendered perpetually fertile without manure, but the luxuriant crops which it raiſes produce manure for enriching other fields; and the manure obtained from that produce is another ſource of national wealth, that could not otherwiſe be looked for. Thus, ſays he, there is every reaſon to believe that the waſtes of the kingdom, if planted or appropriated for paſture lands, or cultivated for the production of grain, or converted into mead, or improved by means of irrigation, muſt neceſſarily be the ſource of infinite wealth and benefit to this country.

And if, continues he, there is a poſſibility of improving our waſtes, the means for that

* Addreſs to the Members of the Board of Agriculture, 1795, p. 20.

purpoſe

purpoſe are more abundantly in our power, than perhaps in that of any other country in the univerſe. Without entering much at length into ſo wide a field, it may be ſufficient to remark, that there is none with ſuch a capital capable of being devoted to ſo uſeful and profitable an object; none where ſuch a ſpirit of exertion exiſts, were all obſtacles to the improvement of our waſtes removed; none where there is ſuch a maſs of knowledge on agricultural ſubjects; none where ſuch abundance of manures are to be found, particularly thoſe of a foſſil and mineral nature, without the aid of which it would be impoſſible to bring great quantities of waſte lands rapidly into cultivation; and, laſtly, none where, by means of a ſeries of excellent roads and canals, everywhere rapidly extending, ſuch manures can be ſo eaſily and cheaply conveyed to the lands they are calculated to fertilize. Theſe are advantages for improving waſtes, which no other country enjoys in equal perfection; and which would ſoon be the means of cultivation of a very large proportion indeed of our at preſent uſeleſs territory, if full ſcope were given to the induſtry and exertions of the people.

Nor ought the wealth to be derived from the improvement of our waſtes to be alone taken into conſideration: the increaſe of population, and, above all, of that deſcription of perſons who are juſtly acknowledged to be the moſt valuable ſubjects that any government can boaſt of, merits to be particularly mentioned. His mind muſt indeed be callous, who feels himſelf unintereſted in meaſures, by which not only the barren waſte is made to ſmile, but of which the object is to fill the deſart with a hardy, laborious, and reſpectable race of inhabitants; the real ſtrength of a country being the fruitful nurſery, not only of our huſbandmen, but alſo of the fleets, the armies, and the artiſts of the nation. The additional number of inhabitants who might thus receive occupation and ſubſiſtence cannot eaſily be aſcertained; but, if the preſent population of Great Britain amounts to about ten millions, theſe waſtes and commons, properly improved, might be the means of adding at leaſt from two to three millions."

Mr. Middleton has thrown conſiderable lights on the great benefits which are to be derived from a regular ſyſtem of irrigation.

* Irrigation,

* Irrigation, ſays he, makes no part of the practice of a Middleſex farmer; he ſuffers the ſtreams to glide by, or through his farm, without interruption; and looks on them merely as conveying the ſurplus water out of the county. When the ſummer's heat is burning up his crops, his only hope is in an early rain: he never thinks of ſupplying the deficiency of moiſture by art. And when the winter's flood overſpreads his fields, in ſome caſes he bewails his misfortune, but dreams not of embanking the land. If his farm is exhauſted, he reſorts to the London dunghills, forgetful of the ſtreams that are running through it, loaded with fructifying particles.

The improvement of land by irrigation, ſays Mr. Middleton, is of the very firſt importance. Wherever the water of this county can be flowed over, and afterwards drained off, any kind of land, at pleaſure, be it ever ſo poor, may be laid to graſs; and by the effect of water alone, raiſed to the higheſt pitch of perfection which meadow land is ſuſceptible of. This is not only

* Agricultural Report of the county of Middleſex, p. 316.

a great

a great improvement, worked without manure in the firſt inſtance, but the land will never want any, or at leaſt not more than it will meet with in the water. The largeneſs of the produce of watered meadow is, at the ſame time, a fund for dreſſing other lands, and particularly valuable to every cow farmer. No other mode has yet procured ſuch early ſpring graſs; and the hay, when mown early, is peculiarly ſuitable for cows, being ſoft and ſucculent. As a cow paſture, no other land would ſupport half ſo much ſtock.

The produce of meadow land in this county is ten pounds an acre per annum; of the arable land, in common fields, eight pounds; light land, incloſed, thirteen pounds. Any of the foregoing ſoils would produce fifteen pounds, if watered meadow.

* Mr. Middleton farther relates, that in Hanworth Park there are about ſixty acres of watered meadow that are leſs perfectly managed than uſual; yet in the middle of September, a lot of twenty acres of this meadow was from ſix inches to a foot deep, in after graſs of the moſt luxuriant quality;

* Agricultural Account of Middleſex, p. 318.

when

when all the unwatered graſs was nearly burnt up. A piece of the ſame park, in meadow duly watered, containing forty acres, in another inſtance, had ſupported forty-ſeven horſes and bullocks, in a mixed ſtock, for three months. On the adjoining land, of ſimilar kind, manured, but not watered, the cut of the ſcythe remained ſtill viſible where the former crop had been mown. Were we to ſearch for a proper ſcite for experiments in this intereſting ſcience, or for a point of concentration from whence the benefits of experiment and example might find a centrifugal diſtribution into the world, which would do honor to the reigning prince, and add luſtre to the antient ſpirit of Engliſh munificence, I conceive the univerſe does not afford a more ſuitable field than the counties of Middleſex and Surry. The city of London is unequalled in the annals of commerce and improvement; and its ſurrounding ſuburbs and country may be rendered equally ſo in horticulture and aration. No river in the world, perhaps, receives ſo plentiful a ſupply of fructifying particles as the Thames, into which the ſewers of London are diſembogued; nor does any river in England offer an equal medium

of

of diſtribution for the fertilizing materials with which the tide is daily charged from this reſource; independent of the interior waſhings into its ſtreams, which that able agriculturiſt, Mr. Middleton, has very amply detailed.

There is no place on earth where gardeners might ſo highly improve their grounds, and eaſe ſo much of their labour by cheap and eaſy machines, as in this neighbourhood; nor is there any ſpot of the globe where the huſbandman might adopt, with greater profit, the method practiſed by the German farmers in America, in the uſe of liquid manure: theſe people ſeem to be among the firſt who have diſcovered the advantages which ariſe from this very eſſence of fertility: and from the means of commanding its diſtribution, at proper ſeaſons, along the drains and ſlopes which their grounds admit of, from a farm-yard, or reſervoir on the ſummit of the field *. All the practical farmers, where I have ſeen the uſe of this or ſimple irrigation, are not only

* See alſo Mr. Joſeph Farmer's Communication to the Board of Agriculture on this ſubject. Communications to the B. of Agric. Vol. II. p. 342.

attentive

attentive to the ſeaſon of the year when ſuch moiſture is neceſſary, but to the hours of the day: for if water is thinly turned upon graſs, and permitted to ſtand during the extreme heat of the ſun, it will ſcald the roots more or leſs, and deſtroy the principal means of vegetation; but if the trenches are ſo conducted, that water can be at all times commanded and turned upon the graſs about ſunſet, permitting it to run ſpeedily off after an overflow of about an hour, it will be found as effective to the full as, or more ſo than, a fine natural ſhower; and the next morning will preſent a fine pearly dew, although the earth in general ſhould be highly parched, and a duſt.

On the other hand, in reſpect to clayiſh or boggy land, ſuch as is apt to retain the water in every hole or foot-mark of an animal, a ſyſtem of irrigation, accompanied with a due attention to draining, would give an equal command of the ſeaſons by art; for perfect irrigation muſt always contemplate the means of commanding water, beſtowing it upon the crop, and turning it ſpeedily off at pleaſure. Both theory and practice confirm theſe points, and they cannot be too much imprinted on our recollection.

Mr.

Mr. Middleton, in ſpeaking farther of the advantages which farms in general may enjoy at the mere expence of their individual proprietor, obſerves, that* a power, effectual and cheap, for raiſing the water in ſufficient quantity to flow about ten acres at a time, would be invaluable; as nearly all the landed eſtates in Britain might be improved by it. Should the power be acquired, he ſays, be it to work by horſes, wind, water, or ſteam, innumerable are the uſes to which it might be applied. The moſt obvious to a farm are threſhing, winnowing, cutting chaff, raiſing water for the uſe of the family and of the cattle, the grinding of malt, linſeed, and corn; but, above all, the raiſing of water for irrigation.

Forty acres of good water meadow, he adds, will ſupport, in the greateſt luxuriance, 500 Wiltſhire ewes and lambs for ſix weeks, from the middle of March to the 1ſt of May; during which time they will improve one ſhilling a week, or pay three pounds fifteen ſhillings per acre, at a time of year when all other farmers are diſtreſſed for a want of food for their ſtock. In

* View of Middleſex, p. 322.

Middle-

Middleſex it would be ſtill more valuable, as five pounds worth of hay might be mown off in the firſt week in May.

The beſt water meadow is probably the mark of perfection in the management of a farm: it follows, of courſe, ſays he, that every poſſible exertion of labour, art, and machinery, ſhould be employed to flow as much land as poſſible.

The general features of highland meadows in the neighbourhood of London, when compared with the neighbouring commons and waſtes, as well as the remarks of Mr. Middleton on a ſubject for which he ſeems ſo abundantly capable by native talent, long experience, and minute obſervation, go fully to ſhew that theſe comparative extremes of fertility and impoveriſhed ſoils, have in former days claimed nearer affinity; and they now afford a ſtriking contraſt as the beſt convincing example of the general capacity of the kingdom: one which certainly demands the attention of the nation, when the concentrated pleaſures of diſſipation will permit our country gentlemen to have leiſure to notice ſuch a happy reſult of experience, and to remunerate themſelves, through a return of its bountiful influence, in their rural concerns,

cerns, as a ſmall degree of recompence for the deteriorations of the city.

Sir John Sinclair corroborates theſe teſtimonies of the arable capacity of the kingdom, in reſpect to its waſte lands, by comparing the ſtate of the markets at diſtant periods of time *. In the reign of Queen Anne, ſays he, when half the ſtock of the kingdom were fed on commons, it is hardly to be credited, in 1710, the cattle and ſheep, ſold at Smithfield market, weighed, at an average, as follows :—Beeves 370 lb.—calves 50 lb.—ſheep 28 lb.—lambs 18 lb.

Now, it may be ſtated—beeves 800 lb. —calves 148 lb.—ſheep 80 lb.—lambs 50 lb. The increaſe is principally, if not ſolely, to be attributed to the improvements which have been effected within theſe laſt ſixty years, and the feeding of our young ſtock in good incloſed paſtures, inſtead of waſtes and commons: add again to this account, the ineſtimable benefits of irrigation.

If I may be permitted to furniſh proofs of extraordinary productions in the preſent highly improved condition of Engliſh ſtock, I may be indulged in ſtating, that at the

* Addreſs on the Cultivation of Waſtes, &c. p. 5.

Vine

Vine tavern in Stafford, where a conſiderable meeting of reſpectable farmers is held on market days, I had the pleaſure of ſeeing in the month of January 1798, a ſample of mutton exhibited by Mr. Princeps, of or near Litchfield, from a ſheep, which the farmers preſent called his ſmall breed. The weights, as then related to me, and noted on the ſpot, were as follow:

	lb.
The fore quarter -	40
Hind ditto - -	32
Per ſide	72
	2
The 4 quarters -	144
5th Quarter at average	36
	180lb.

The prize ſheep, for the year 1799, lately exhibited among other competitors for this laudable ſpecies of premium, was of the old Glouceſterſhire breed, bred and grazed by Mr. Poulton, of Crickdale, Wilts.

He was killed by Meſſrs. Hiſcock and

Farrow, of Reading. He meaſured ſix feet five inches and a half in girt, twenty-ſeven acroſs the back, twenty-two inches over the ſhoulders, and ſtood only twenty-ſix inches high. His depth of fat was, on the rump, eight inches, on the ribs ſix and a half inches; and his weight twenty-ſeven ſtone * and ſeven pounds.

The fat hog, belonging to Mr. William White, of Kingſton in Surry, killed 28th March 1798, was—

4 feet high,	2½ years old,
8 feet long,	49 ſcore 6lb.
9 feet 2 inches girt,	70 ſtone 6lb. at 14lb. per ſtone,
5 inches fat all over,	123 ſtone 2lb. at 8lb. per ſtone.

It was generally allowed that this hog might have been fed to double this ſize.

The prize heifer, was bred by the Duke of Bedford, and purchaſed by Mr. Hoad, of Wapping, for forty pounds.

* The ſtone of meat is 8lb. horſeman's weight, 14lb. and ſaid to be 16lb. per ſtone in ſome other caſes unknown to me.

Her

Her meaſure.	f.	i.	*Her weight.*	ſt.	lb.
Height -	4	2	Weighed -	107	7
Girt - -	8	2	Tallow -	14	0
Length -	7	0	Hide -	8	0

The prize ox, was fed by Mr. Weſteart, of Buckinghamſhire, and purchaſed by Mr. Chapman of Fleet Market.

He was	Weight.
6 feet 7 Inches high,	*241 Stone 3lb.
Girt 10 feet 4 inches,	36 Stone—4 Tallow,
Length 9 feet,	29 Stone—0 Offal.

I have before ſtated, that I am particularly deſirous to ſee the introduction of irrigation into the Northern Counties, as one of the primary means of improving the extenſive waſtes, more eſpecially of Lancaſhire, Yorkſhire, Cumberland, and Weſtmoreland. Concerning the laſt of theſe counties I have had many converſations, and have often been oppoſed with the arguments of impracticability: that there was nothing there to pay

* Mr. Jefferſon ſtates the heavieſt cattle which he had known to have been weighed in America, as follows:—Cow kind 2500lb.—Hog 1200lb.—Sheep 125lb. See Jefferſon's Notes, p. 80.

carriage upon a ſmall canal, no land worth improvement, and that the climate was unfriendly to culture, &c.; as if gentlemen were predetermined to ſhut their eyes againſt conviction, and jogg on in the old beaten track of their anceſtors, notwithſtanding the advancement of ſcience, or conſiderations of private income.

In regard to the improvement of the Lancaſter and Ulverſtone ſands, (which *I* have no heſitation in ſuppoſing capable of reduction to a permanent ſhip channel of a conſiderable capacity, and to a vaſt acquiſition of verdant meadow, which would amply repay the adventures of ſpeculation), I am led to deſpair of ſeeing any man ſucceſsful in bringing the parties moſt concerned to view the operation as a thing practicable; more eſpecially as I have learnt, that the efforts of Mr. Wilkinſon's talents, the offers of his purſe, and the influence of his fortune, have been inſufficient to awaken the neighbouring gentlemen to a ſenſe of their own, or the national intereſt in this great undertaking.

I have, however, been at ſome pains to impreſs the idea of ſuch a ſmall interior undertaking, as ſhould afford an eaſy transfer by

by water through the Weſtmoreland Lakes; for the diſtribution of ſea ſand as a manure for the barren heath, and an eaſier return than the preſent mode affords, for the ſlate and materials which have already forced their way to market.

In anſwer to this propoſition I have been frequently told, that it had been long aſcertained that the deſign was impracticable, or at leaſt very doubtful; that the place had been ſurveyed long ago, and the undertaking diſcountenanced; and that the country afforded nothing to carry.

I find on a later inquiry, that about twenty-eight years ago ſome gentlemen of the neighbourhood took an eye-view of the premiſes, and being perhaps, from this very ſlight attention to the ſubject, thus perſuaded at that period, the opinion of the fathers has been ſwallowed by the children. I learn that ſuch a communication, at the preſent day, would at leaſt accommodate transfer for a ſet of iron works upon the Lakes; a fine cotton manufactory; conſiderable quantities of ſlate, lime ſtone, and charcoal; beſides their reſpective returns; the articles of ſea ſand, and other manure; the ordinary occaſions of the country; the fiſhing of the Lakes and ſea; the proſpects of fu-

ture foreſts and agricultural productions; and the various acquiſitions which reſult from irrigation.

* In regard to the climate of ſuch waſtes, ſays Sir John Sinclair, it is evidently worſe for the want of cultivation. At the ſame time, from the inſular ſituation of Great Britain, the climate is infinitely milder and better than in any part of the Continent, of the ſame latitude. It is ſtated in one of the reports, on the moſt reſpectable authority †, that very fine barley and oats ripen in due ſeaſon on the ſummit of a hill in Forfarſhire, elevated 700 feet above the level of the ſea; and that in Inverneſsſhire, at an elevation of 900 feet above the ſame level, wheat of a good quality has been grown. Hence it may be inferred, that grain, and other articles of a ſimilar nature, may be raiſed to ſuch a height upon the ſides and ſummits of all the hills in the iſland; and, in regard to graſs, it is well known that luxuriant crops of hay are obtained at the Lead Hills in Lanarkſhire, elevated 1,800 feet above the ſea. The climate of this country, therefore, can

* Addreſs on Incloſed Lands, &c. p. 19.

† See Prelim. Obſerv. to the Report of Forfarſhire, by G. Dempſter, Eſq. p. 6.

hardly

hardly be urged as an objection to the improvement of the greater part of our waſtes, either for grain or grafs: as to trees, it is not to be queſtioned that the *larch* grows in Italy on higher mountains than any we have in this iſland *.

In regard to the perfection to which that very uſeful tree, the larch, may be reared in Great Britain, Doctor Anderſon mentioned to me, a few months ago, a ſufficient example to call for a more general plantage of them. There is one, he ſays, in Scotland, of fifty-two years old, which is four feet in diameter, and one hundred and twenty feet high. This proves ſufficient to eſtabliſh the Britiſh climate as a ſuitable element for this kind of culture.

In the Appalachian Mountains, in America, the larch tree grows ſpontaneouſly in great abundance and ſome variety. It ſeems to delight in a cold clayey ſoil, of a yellowiſh caſt, which abounds there in many of the deep valleys having a bleak expoſure; and it flouriſhes both in the watery vale at the foot, and from thence up the mountain

* See Weſtm. Rep. Prelim. Ob. p. 9. See, alſo, Mr. Pontey's late pamphlet on the Culture of Larch Trees.

to its arid ſummit. When I was laſt in the Tenaſſee Country, 1793, there ſeemed to be a ſufficiency of young plants in the ſpurs of the Iron Mountain, (where the Indian Creek road paſſes from Little's Ford upon Holton River to Wautauga), to ſtock all the waſtes in Great Britain. It might be eaſy to procure them from thence at proper ſeaſons, becauſe waggons are continually paſſing from thence to the ſea ports of Richmond and Peterſburgh; and their proprietors would readily attend to the ſubject if they found an intereſt in it.

Sir John Sinclair ſays, the higher ſituated and the moſt ſteril parts ought, undoubtedly, to be devoted to plantations. There is ſcarcely, ſays he, any ſpot however rocky, or any ſoil, however unproductive, that will not yield valuable timber—an article which we are under the neceſſity of importing, at a great expence, from foreign countries. At firſt ſight it may ſeem ſurpriſing, that a ſpot that would not produce a ſingle blade of corn, will yet ſupport the ſtately pine, or ſpreading oak. But trees draw their nouriſhment from ſources beyond the reach of ſmaller vegetable productions, and by their leaves are alſo ſuppoſed to derive additional

ſuſtenance

ſuſtenance from the air that ſurrounds them, or the water they imbibe. By plantations alſo, even barren ſpots may be rendered fertile.

The pooreſt ſoils, if covered with wood, from the leaves which fall, and the ſhelter they receive, improve every year in fertility; and, when the trees are ready for the axe, become, in proceſs of time, fit for cultivation.

"Many of the higher waſtes in the iſland, ſays he, may be rendered perfectly dry," (for drainage and irrigation ſhould be always found in each other's company), "and ſoon converted into excellent upland paſture. There that valuable article, fine cloathing wool, might be grown to perfection. The loftier the ſituation, and the ſhorter the herbage, the more valuable it would be; and the price which the article bears, joined to the profit of the carcaſe on which it grew, would amply compenſate for all the expence of improvement.

A much greater proportion of the waſtes of this country, than is commonly imagined, might be employed in tillage. The ſurface may appear barren and unproductive, but ſtratums may be found below, which, if incorporated

corporated with the ſoil above, may render it ſufficiently fertile. This is a practice in huſbandry which has not yet been carried in any degree, to the extent of which it is capable. It is an art pretty much in its infancy, which, when brought to its perfection, muſt be productive of the moſt important conſequences. As ſuch, it will naturally call for the particular attention of the Board of Agriculture, to aſcertain the principles upon which it can beſt be conducted."

May I not then aſk, with propriety, Where are the principles which lay ſo ſure and great a foundation for general improvement as thoſe of *irrigation*? Or, Where are the countries which may be more improved than *Weſtmoreland*, *Yorkſhire*, *and the Northern Counties*, through its offices in inland navigation, watering, and draining?

I am aware again, that if I aſk where the difficulty lies in extending a canal from the Ulverſtone ſands into the lakes, that the old hackneyed principle will be oppoſed to me, without diveſting it of its antiquated incumbrances; and that I ſhall be told that canals are impracticable throughout that ſteril country, becauſe it has no trade which is ſufficient

ſufficient to remunerate intereſt upon the monies it will require.

Now my ſuſpicions are, that this mode of reaſoning ſets out upon a falſe poſition, and muſt therefore end in fallacy. It ſeems to preſuppoſe that hydraulic genius has been long exhauſted, and reduced to ſtandard, without either allowing latitude for the progreſs of improvement, or remembering a multitude of recent proofs, that very few, if any caſes exiſt, where the expence may not be ſo proportioned to the object, as to found the enterprize upon ſome degree of rational experience, and overcome the impediments of nature through perſeverance in the paths of art.

If the country was full of commercial riches, I dare ſay the ſpirit of the nation would make no great difficulty in extending a canal from Carliſle to Newcaſtle for a ſhip of the line; but as this wealth is yet to be ſubject to the doctrines of acquiſition, and the aſſiduity of induſtry, the ſite is not ſufficiently ripened for ſuch an undertaking; and poſſibly other plans may prove equally as deceptive, when begun at the wrong end of the buſineſs, and limited by ſturdy precedent,

cedent, and by an obſtinate twenty-five ton boat.

If we were to judge comparatively of an Engliſhman and a Frenchman, from the contempt which the former is wont to beſtow on the latter, one would imagine that a native of Great Britain ſhould be aſhamed to be indebted to his inferiors for precedents of enterprize: yet it has, ſomehow or other, ſo happened, that theſe contemptible Continentals have executed an undertaking at Languedoc, which holds out precedents to Newcaſtle; and have irrigated the barren diſtrict of La Crau; perhaps a thouſand times inferior to thoſe waſte lands of Weſtmoreland, which are producing the moderate ſum of one penny per annum per acre for ſheep ſtarving; amounting, at twenty-four years' purchaſe, to the price of an American barren wilderneſs, a pitiful two ſhillings per acre *.

As I happen not, on my part, to be one of thoſe who bow down to the ne plus ultra of human invention, which the Nebuchad-

* See the Report of this county to the Board of Agriculture, or the recital in Sir J. Sinclair's Addreſs concerning Incloſures.

nezzars

nezzars of hydraulic perfection may have ſet up, I am confident enough to ſuppoſe it practicable to improve the navigation of the Cartmel and Ulverſtone ſands, or perhaps to reclaim them; to conſtruct an uſeful ſea port at their head; to extend inland navigation advantageouſly into the lakes, from Carliſle to Newcaſtle, and from Rippon to Carliſle: for although none of theſe may be practicable in reſpect to immediate commercial returns, they would ſeem to be all ſo in regard to agricultural canals and irrigations; and are indeed amply within the powers of finance, and that patience which abideth future remuneration.

In any caſe it would be a material conſideration, if ducts of irrigation only could be extended to the regulation of the ſeaſons. Yet, when we are conſidering how far the proſpect extends of improving a waſte and ſteril country, in which very few ſubjects of preſent commerce exiſt, to call in the co-operative functions of canal transfer, towards leſſening the expence of conſtructing mains for the purpoſe of agricultural irrigation, we are called upon by prudence and forethought to look forward into future periods of

of time, and to conſider what are the probable proſpects of produce and material, which the nature of the country may promiſe to afford from its ſurface by means of culture, or from the bowels of the earth, by means of art and manual labour. For although the country does not admit of extenſive navigation upon a large ſcale, without merchandiſe to ſupport it by transfer, yet there are many primary conſiderations of agriculture which may be aſſiſted by the powers of finance, to extend a ſmall canal into a very ſteril country, upon the ſtrength of its future proſpects; and ſuch undertakings will be found invariably to carry population and improvement along with them.

Of cultivating the Larch Tree, in Connexion with national Irrigation.

Mr. Pontey, who has lately written a Treatiſe on the Culture of the Larch Tree, accompanied with ſpecimens of the wood produced from it, has furniſhed a demonſtration of an ample reſource, in this particular,

ticular, towards carrying cultivation to a degree of perfection which many proprietors would ſcarcely believe; yet, poſſibly, throughout the barren moors and heaths of the northern counties: and I am the more induced to credit the univerſality of his ſtatements, both from the luxuriance of many varieties of this tree, which I have noticed in ſome of the moſt ſteril ſoils of America, and from the abundant variety of thoſe ſoils in which I have ſeen this tree flouriſh there, in a ſtate of nature, even from the deepeſt valley to the mountain top.

Mr. Pontey ſtates the culture of theſe trees, in three-feet rows, at 4840 per acre; but prefers to plant them in four-feet rows, containing 2722 plants per acre. In the progreſs of the growth of either, it will of courſe follow, that the thriving of the trees will regulate the mean product which will ariſe from ſucceſſive thinnings of them for tranſplantation and other uſes. He furniſhes alſo an actual example of a plantation of 4194 trees per acre of various ſorts, in which the luxuriance of the larch rendered it abſolutely neceſſary to be very attentive to thinning, to prevent the other trees from being

being ſmothered by it. This plantation contained

145,000	Larch
72,500	Scotch fir
50,000	Aſh
40,000	Sycamore
45,000	Elms
600	Oaks
600	Spruce fir
30,000	Birch
10,000	Mountain aſh
400	Weymouth pine
200	Horſe cheſnut
Total 394,300	Trees.

It may afford both ſatisfaction and occaſional data to ſtate, that the trees from which the intereſting ſpecimen of larch wood, which accompanies Mr. Pontey's book, was taken, were of about thirty-five years growth, containing about 28½ feet of timber each, or 199 feet in ſeven trees, produced by a thin ſoil, with a looſe bottom of reddiſh yellow ſand.

If, by way of example, we take 100 acres of Weſtmoreland ſheep-walk, ſuch as Sir

Sir John Sinclair and the Biſhop of Landaff have ſtated, at a rent of one penny per acre, at thirty years purchaſe, we muſt call its preſent value 12l. 10s. Add to this, the ſum of 1000l. for fencing and planting, which correſponds with Mr. Pontey's allowance. Each lot of one hundred acres of new plantation completely fenced, would thus be worth 1012l. 10s.; which ſum, placed at compound intereſt for thirty-five years, would amount to 5585l. within a few fractions.

Now if we take the plantation of 100 acres to be in four-feet rows, as Mr. Pontey recommends, there will be 2722 plants to each acre of ground, amounting to 272,200 plants per 100 acres.

And, if we ſuppoſe only one third of theſe trees to come to maturity in thirty-five years, agreeable to the ſpecimen of larch wood exhibited with Mr. Pontey's book, and allow the other two thirds only to equal the coſt of attention and repairs of fencing, &c. (which, it is preſumed, will be greatly exceeded by the tranſplanting and other mean profits in the progreſs of thinning and culture) there will be ultimately

matured, in this time, the quantity of 90,733 trees. And, as we may allow each ſeven trees to yield 200 feet of timber, the produce of each lot of 100 acres will be 2,512,200 feet of timber.

In this way of reckoning it would follow to ſtate the value of this timber, in order to come at the produce of ſuch land by planting it; but as I am not informed on this point, and am without the means of reference, I will adopt Mr. Pontey's method of computation.

This gentleman admits a tract of barren land, ſo termed for its bleakneſs, to yield not leſs than 12l. per acre in ſtanding trees of thirty years growth, valued at 1s. 6d. each, after making every requiſite deduction for deficiency and expences: and, according to this method of computation, we may, I preſume very fairly, ſtate an account of the outgoings and profit upon a hundred acres of Weſtmoreland ſheep-walks, employed for thirty years in larch plantations, as followeth:

Value of 100 acres land, yielding 1d. per acre rent, at thirty years purchaſe, together with fencing

fencing and planting, to the amount of 1000l.—both at thirty years allowance of compound intereſt -	£.4375 18 4½

At the end of 30 years, ſay,

100 acres ſtanding timber, at 125l. per acre - -	12,500 0 0
Prime coſt, or value of land ſtill remaining - -	12 10 0
100 acres improved by ſhelter, valued at 3s. per acre, at 30 years purchaſe -	450 0 0
Ultimate value of premiſes	12,962 10 0
Deduct ſum laid out, and compound intereſt -	4,375 18 4½
Gain per hundred acres by planting - -	£.7,586 11 7½

Now I will venture to ſuppoſe, that if this poor barren country in the northern counties had no other improvement to expect profit from, or no other capacity than that

of growing larch trees, that this is of itſelf a ſufficient inducement to juſtify the immediate conſtruction of canals; and we will, for argument ſake, look upon all other reſources out of the queſtion; and they will of courſe be conſidered a clear gain, if others ſhould ariſe unexpectedly.

I will therefore proceed to demonſtration on the ſole reſource of plantations: I will ſuppoſe that either Government, or an incorporated company, ſhall commence an enterprize on the 1ſt of January, 1801, which contemplates the cutting of canals, and the rearing of timber in conjunction, without any proſpect of remuneration till the year 1831, when both the crops of the plantation and the tolls of the canals will very certainly be ripe for retribution. I will allow the proportion of 100 acres of plantation per mile only, to be the quantity of poor land planted by the concern, ſo as to depend on ſo much territory in the aggregate, being within reach of the canal or its various ramifications.

To give the ſubject fair play, I will allow the extent of one hundred miles of main canal to be laid out in a direct line through the country, and one hundred miles of ſmall canals

canals to form its diſtributive branches: let the main canal be ſtated at two thouſand pounds per mile, and the ſmall or branch canal at one thouſand pounds per mile, both incluſive, and the account will ſtand as follows:

Outgoings upon this Operation for Thirty Years.

100 Miles main canal, at 2000l. - - -	200,000 0 0
100 Ditto branch ditto, at 1000l. - - -	100,000 0 0
20,000 Acres, fenced and planted in lots of 100 acres each, ſay 200 lots, at 1500l. each - - -	300,000 0 0
	600,000 0 0
Five per cent. intereſt upon the above for 30 years, at 30,000l. per annum -	900,000 0 0
Total principal and intereſt	£.1,500,000 0 0

State of the Property acquired at the end of Thirty Years.

20,000 Acres of land, at 5l. per acre prime coſt or value	100,000 0 0
Improved value by ſhelter, at 3l. per acre, at thirty years purchaſe, for 20,000 acres - - -	90,000 0 0
20,000 Acres ſtanding timber, at 1s. 6d. per tree, or 125l. per acre - -	2,500,000 0 0
Land with 30 years crop £.	2,690,000 0 0
Deduct the whole principal and intereſt expended, to be now paid off	1,500,000 0 0
Gain (beſides clearing the canal) - - £.	1,190,000 0 0

Thus, if we only admit the mean profits of the canal, grazing of cattle, &c. to pay the trouble of attending to the buſineſs, we find, that at the end of thirty years operation, ſubſcribers for ſhares will have been paid

paid more than ſeven and a half per cent. per annum for the uſe of their money; and will have moreover cleared the whole property of the landed eſtate and canal into the bargain.

Yet much more than this, of right, belongs to the generative faculties of irrigation. In France, Mr. la Lande ſays *, the canal of Provence draws, on one thouſand toiſes of its extent, no leſs a ſum than one million of livres per annum rent, for agricultural irrigation alone; and I can ſee no reaſon why any of the improvements of England ſhould be either leſs valuable, or more procraſtinated than thoſe of France.

I preſume I need give no farther example on this ſubject; yet it may be proper to ſubjoin the computations of a learned prelate of the county of Weſtmoreland, as an authority to keep my own works in countenance, leſt they be imputed to a viſion.

The Biſhop of Landaff, in his preliminary obſervations, prefixed to the report of the ſtate of agriculture in this county, obſerves that it may be of uſe to ſtate the pro-

* See Young's Tour, p. 368, or Des Canaux de Navigation, p. 175 to 184. Folio, 1778.

bable profit which would attend planting the waſte lands of this country with larch trees. He ſays, "a thouſand acres of this ſort of land might be incloſed with a circular wall, ſix feet in height (where the ſtones can be eaſily gotten, as they may in moſt parts) after the rate of 6s. an acre, or 300l. for the whole; 500 larches, two feet in height (ſo as to enable them to reſiſt the long graſs) might be planted on each acre for 14s.; hence a plantation of 500,000 might be made for 1000l. Now 1000l. improved at compound intereſt, at the rate of 4l. per cent. would, in ſixty years, amount to the ſum of 10,519l.; this is the accumulated loſs attending the incloſing and planting 1000 acres of rocky land in ſixty years.

The rent of 1000 acres, at 1d. per acre, is 4l. 3s. 4d. a year; in eight years, the larches would be out of all danger from ſheep; ſo that the loſs of rent ought only to be eſtimated for eight years; but 4l. 3s. 4d. a year, though improved after the ſame rate of compound intereſt, would not amount to 40l. in eight years; ſay, however, that it would amount to 81l. which is allowing more than 2d. an acre for the annual rent of the land, then would the whole expence attending

attending the plantation in ſixty years be 10,600l. I have here ſuppoſed ſheep to be ſhut out of the plantation for eight years; if it ſhould be found that ſheep will not crop the larch, and from more than one obſervation I have reaſon to believe they will not, they need not be ſhut out at all; nor in diſtricts, where nothing but ſheep are depaſtured, need any fence be made. I know the advocates for cloſe planting, inſtead of 500, would require 5000 larches for each acre: I am not convinced of the utility of ſuch planting, except where it is intended to raiſe up oaks, or other kinds of wood; but if that mode ſhould be adopted, the thinnings, after twenty years growth, would pay the expence of it.

At the expiration of ſixty years, ſuppoſe that only 250 larches remained on each acre, or that one half had periſhed, the probable value of them may be thus eſtimated. From a great many experiments made by myſelf, and collected from others, I find the annual increaſe in circumference of the larch, at ſix feet from the ground, to be one inch and one half on an average of ſeveral years; and this inference has been drawn from the actual admeaſurement of larches in different parts

Outlines of a Canal Syſtem recommended to the Conſideration of the Counties of Cumberland and Weſtmoreland, in purſuance of the foregoing Principles.

Before I take leave of the irrigation and its relative improvements propoſed for the Northern Counties, I am prompted, by a true regard for the proſperity of my native ſpot, to recommend to its landholders in particular, and generally to its inhabitants, an earneſt attention to thoſe powers of combination which art has preſented to their aſſiſtance as the victor over difficulty: the extention of canals, the irrigation of the ſoil, and the planting of timber trees, ſhould every where combine to ſpread a general acquiſition of wealth in lieu of their barren waſtes; and it is every where practicable, even high in the region of Skiddaw. Mr. Leache's maxim admits canals into every country which has water enough to turn a mill; the improvements of France and of Devonſhire have pointed out an application of their ſurplus water to the enrichment of their ſoil; hydraulic improvements have eſtabliſhed the practibility of giving any degree of ſurplus

water

water to any degree of elevation; and various inclined plains have proved, by practice, that any line of canal may be connected with its higher or lower level, (even over the top of a mountain), although water ſhould prove deficient for the waſtage of a pound lock.

In ſuch a ſtate of ſcience, what may not be practiſed by enterprize and induſtry? It remains but to calculate the expence; and even that dwindles to nothing in the preſence of unanimity. Let us then explore the field of operation; but let us alſo remember that canals for transfer and irrigation will water moſt land by keeping the higheſt convenient level.

I apprehend the firſt thing to be conſidered, in all great improvements of this kind is, what lines of direction have been aſſigned by nature; for theſe ſhould always pervade the general ſyſtem, with every aſſiſtance which art can beſtow; and nothing but ſome very partial exception will ever be ſufficient juſtification to turn nature out of her courſe.

Thus it is much eaſier to conduct a line of canal through a hilly country than a level one, and much ſafer for the adventurer; for

nature

nature has ſaid in both caſes that ſhe will limit the operation in defiance of the caprice of man, or the competition of evil doers.

Now wherever nature has directed a line of communication, from one great town to another, through an interior country, and thro' a ſteril one, it becomes intereſting to the commerce of both places to join the improvement of the barren waſte with the communication of their commercial intercourſe and proſperity. The country we are ſpeaking of preſents many ſuch ſituations: as for example the following.

1ſt, A canal from Ulverſtone ſands to Carliſle, would run nearly as follows:

	Miles.
Up the river Leven, from its mouth, to the lower end of Winander-meer, a little above Newby Bridge,	4
Up Winander-meer to the mouth of the river Brathey - —	10
To Rydale Hall — — —	1
Up Rydale water to the head of Graſs-mere — — —	2
Up a brook that empties into Graſs-mere water to Townhead toll-gate,	2¼
Carrried forward	19¼

Through

	Miles.
Brought forward, — — —	19¼
Through Dunmail rays gap to the waters of Thirle-mere —	1
Down this brook to Thirle-mere	1¾
Down Thirle-mere to Smalthwaite Bridge — — — —	3
From Smalthwaite Bridge down Greata river to its junction with the Threlkeld branch of that river,	3
Up that branch by Threlkeld, Dud-dock, and Sales, to Moor End -	3
From Moor End to the Point of Partage at Mungris Dale —	2¼
Over that Point of Partage to Caldew river where the road to Moſsdale croſſes it — — —	1
Down that river to Heſket-new-market — — — —	5
To the mouth of Caldbeck-branch	1
To Sebergham — — —	2
Down Caldew river to the mouth of Roughton head-branch thereof	3¾
To Dalſton — — —	2
And, down the remaining part of the river Caldew to Carliſle —	4
In all	52

Which

Which may, perhaps, be ſafely computed to be within *one* thouſand pounds per mile; if it were even neceſſary to cut a canal the whole length of the line.

The principal lateral cuts or branches which nature has connected with the above line of main canal (not including many ſmall and perhaps intereſting ramifications), are, 1. From Ambleſide to Penrith. 2. From Ambleſide to Ravenglaſs, by way of Coniſton. 3. From Threlkeld to Keſwick, with branches from thence to Workington, Whitehaven and Ravenglaſs. 4. From Scales to Penrith, by way of Dacre and Dalemain. But it will be obſerved, nevertheleſs, that each of theſe lateral branches runs in ſuch a direction as to meet ſome other branch, by which means a line of direct communication is formed throughout the Counties of Weſtmoreland and Cumberland, from one extreme angle thereof to another, in almoſt every direction where the moſt intereſting conſiderations of agriculture and commerce can be brought in contact, as it were, with each other; and to mutual and reciprocal advantage. In reſpect to irrigation, it is nevertheleſs pertinent to obſerve, that the ſyſtem of canals herein pointed out will, when

when applied to my propoſed national ſyſtem, operate rather as catch-water drains, and general ſewers, than as leading mains or conduits for ſupplying a ſuperabundant reſource: they will, nevertheleſs, in this regard contribute abundant facility to the general ſyſtem; and they can be made to act alternately, for the better command and diſtribution of the water. They will, in this view, ſave an abundant expence; in as much as while they equally perform the functions of transfer, they will alſo convey water from the ſea or lakes, to the points at which nature may have preſented the leaſt interrupted perpendicular lift or inclination, for elevating this national fluid to the back-bone of the country, and to the ſummit levels of the grand reſervoirs.

It follows to detail the particulars of the ſeveral lateral cuts or branches of navigation of which we are ſpeaking; and from theſe an approximate eſtimate may be obtained of the expence of extending a line of communication in any direction which is required.

1. *Canal from Ambleſide to Penrith.*

	Miles.
From Ambleſide to the head of the brook which waters that place -	2½
Thence to the waters of Broader –	1½
Down to Broaderwater Lake –	1
To Saint Patrick's well at the head of Ulles-water Lake – – –	2½
Down Ulles-water Lake to Powley Bridge – – – –	7
To Dalemain – – – –	2
To Penrith – – – –	2½
In all	19

2. *Canal from Ambleſide to Ravenglaſs, by way of Conniſton.*

From Ambleſide up the river Brathy to a point oppoſite Skelwith –	2
Thence to the Three Tarns – –	2
Thence to Conniſton – – –	3
Offset to encompaſs Conniſton Lake	1
From Conniſton to Dunnerdale –	4½
Thence to Devock Lake – –	3
Down that Lake – – –	1
To Mulcaſter – – – –	3
To Ravenglaſs – – –	1
In all	20½

3. *Canal from Threlkeld to Keſwick; and thence to Workington, to Whitehaven, and to Ravenglaſs by different routes.*

This branch admits of the following diviſions:

1. *From Threlkeld to Keſwick.*

	Miles.
From Threlkeld to Weſcow –	1
To Keſwick – – – –	2¼
In all	3¼

2. *From Keſwick to Workington.*

From Keſwick to Highſtock Bridge	2
To Baſenthwaite water – –	1½
Down the Lake to Ouſe Bridge –	3
Down Derwent river to Iſle –	2
To Cockermouth – – –	3
To Little Clifton – – –	4
To Cummerton – – –	1½
To Workington harbour – –	3
In all	20

3. *From Keſwick to Waſtdale-head.*

	Miles.
From Keſwick to the mouth of Grangebeck, at the head of Derwent water – – – –	3
Up Grangebeck to Styehead –	5½
Thence to Waſtdale-head – –	2
In all	10½

4. *From Waſtdale-head to Whitehaven.*

From Weſtdale-head to the head of Liza river – – – –	2
Down that river to the head of Ennerdale Lake – – – –	3
Down Ennerdale – – –	2¼
To Ennerdale – – – –	1
Down the river Ehen to the Bridge on the road from Ennerdale to Whitehaven – – –	3
Thence to Whitehaven round the hills – – – – –	5¾
In all	17

5. *From*

5. *From Waſtdale-head to Ravenglaſs.*

	Miles.
From Waſtdale-head to the head of Waſtwater Lake – – –	1
Down that Lake – – –	3
From the Lake to Waſtdale –	1
Down the river Irt to Stanton –	2
Thence to Carleton Bridge –	3
Thence to Ravenglaſs – –	2
In all	12

There are alſo three lateral cuts, connecting various points with this firſt main line which extends from Ulverſtone to Carliſle. They are, 1. From Conniſton down the Lake to the head of Ulverſtone ſands. 2. From Caldbeck to Baſenthwaite water; and, 3. From Orthwaite Hall to Abbey-holme.

1. *From Conniſton to Ulverſtone ſands.*

	Miles.
From Conniſton to the Hall –	1
Down the Lake to Hawthwaite –	1
Carried forward	2

	Miles.
Brought forward – – –	2
To Peel Iſland – – – –	2
To the bottom of the Lake –	2
Down the river Crake to Lowick –	1½
To Ulverſtone ſands at the mouth of the river Crake – – –	2½
In all	10

2. *From Caldbeck to Baſſenthwaite water.*

From the mouth of the Beck to the Town – – – –	1
To the head of that Beck – –	4
To Orthwaite Hall on the Point of Portage – – – –	2
To Baſſenthwaite Hall – –	2
To the Lake – – – –	1½
In all	10½

3. *From*

3. *From Orthwaite Hall to Abbey-holme.*

From Orthwaite Hall down the river Ellen to Ireby – – –	4
From Ireby to a point in the river near Bolton – – – –	1
Thence acroſs the Partage to Waverton on the river Waver – –	3½
Down the river to Ware Bridge –	2
Thence to Abbey-holme – –	5
In all	15½

There remains, under the ſecond general head, one grand trading line from Milnthorpe, at the head of the Lancaſter ſands, to Carliſle by way of Kendal and Penrith. I will not now take into the eſtimate any of the great leading points which are preſented to the eaſtward of this line; ſuch, for inſtance, as the communications into Lancaſhire, and Yorkſhire, thoſe leading towards Appleby, and from Appleby and Carliſle towards Newcaſtle, and into various parts of Scotland. I ſhall probably find ſome future occaſion to take a diſtinct view

Hence, if we make no allowance whatever for the lakes and rivers, but ſuppoſe them to be merely feeders to the canals, and allow the very ample ſum of 1000l. per mile, which (eſtimating all circumſtances) will, I preſume, be fully ſufficient, we ſhall find 250,000l. or one quarter of a million, will be enough to lead all the improvements of agriculture and commerce into every acre of thoſe waſtes with which Cumberland and Weſtmoreland ſo greatly abound. It is unneceſſary here to repeat thoſe computations which demonſtrate a powerful reſult. The Biſhop of Landaff has thrown ſufficient light on that ſubject; and it is anxiouſly to be hoped, that the means which fortune has furniſhed to the noble Earl of Lonſdale, and to other powerful proprietors, will be ſo applied as to give greater abundance to the nation, and ſhower the bleſſings of a benign influence on the crowd which may be left behind them. I will not deſpair of this happy reſult; for, in ſpite of the buſy hints of fame, it muſt be indeed a ſad reflection to declining years, if men were to look back on their paſt life without pleaſure, and on their approaching diſſolution with that well-deſcribed terror of the Pſalmiſt, which would hide

hide its guilty head beneath the mountain chaos, rather than encounter the terrible reflection of having lived ſhort of their power and talent to do good while they remain on earth!

HORTICULTURAL IRRIGATION.

In regard to the ſmaller ducts of irrigation, ſuch as are adapted to horticultural application, I beg leave to inſert an account of an experiment tried by me in Virginia, and communicated to Doctor Anderſon for the uſe of his ineſtimable periodical work, entitled, Recreations in Agriculture, Natural Hiſtory, Arts, and Miſcellaneous Literature. I recite this with his approbation, that this little work may be in ſome meaſure enriched by practical hints, ſuch as, I flatter myſelf, will apologize for repeating a few deſultory communications in a more collective method.

Some years ago, during a dry ſummer in Virginia, I was led from obſervations on the parching effect of the uſual mode of watering plants with a watering pot, to conſider the principle of operation upon the earth and plants relatively in a vegetative ſtate.

ſtate. I obſerved, that when this method was uſed about ſun-ſet, it had generally, but not always, a good effect in moſt kinds of ſoil, and produced a pleaſant dew upon the graſs and leaves on the following morning; but if the watering pot was too freely uſed during the mid-day heat, or even in the morning, it cauſed the earth to parch, and checked the progreſs of vegetation, until an annihilation of the vital principle was effected.

From an extenſion of this remark upon the larger ſcale of agriculture, which is afforded in the proceſs of cultivating maize, or Indian corn, I am perſuaded that, after plants in general have attained to a permanent radification, it is beſt to work the ground frequently, whether the weather be wet or dry; and, except in the caſe of tobacco, and ſuch other plants as we expect profit from through the curable condition of the leaf, I think a continual working of the ground will be found a better aſſurance for the crops than watering only.

I was ſatisfied, however, that the beſt modes of ſupplying a deficiency of rain were not yet diſcovered. The difficulty was how to ſupply the regular demands of vegetative

tative ſucceſſion through a droughty ſeaſon, with a juſtly proportioned ſubſtitute for the evaporated ſubſtance of the earth, by which it would otherwiſe have been ſuccoured.

Hence (water being the natural element aſſigned to this purpoſe in its ſimple ſtate) I had recourſe to the experiment of a ſyphon made of twiſted cotton.

I ſelected two water-melon vines near each other, in ſoil of the ſame appearance; one of them being conſiderably more flouriſhing than the other. I made my experiment upon the declining vine, by gently twiſting a cotton ſyphon, made of candle wick, proportioned to the ſtem of the plant; I then elevated a pot of water above the ſurface of the ground, covering it from the vehement heat of the ſun with a piece of plank.

Fig. 1.

Having then wetted my ſyphon, in order to communicate motion to the fluid upon the ſimple fountain principle, I tied a ſmall ſtone to one end, as a weight to ſink it when immerſed in the water; and dropping this into the pot, I paſſed the other end down into the earth,

earth, by ſcratching the mould gently away from the root, and giving the ſyphon a ſpiral direction round it, covered lightly with replaced mould.

In a ſhort time the earth became moderately moiſtened a few inches round the root of the plant, in which condition it continued through the heat of the day, without parching or ſcalding; the ſyphon ſupplied the demand of the plant, and no more; a cool ſucceſſion took place through the effects of evaporation; and in a few days the vine became flouriſhing, and outgrew its neighbour.

I have repeatedly tried this experiment with good effect, and think it at leaſt capable of extenſion in a garden or nurſery.

Fig. 2.

Explanation

Explanation of the Plates.

Fig. 1. An earthen jar, containing water, placed on a bench for the purpoſe of elevating the water above the plant which is to be irrigated upon the fountain principle. A, twiſted rope of cotton or wool, proportioned to the ſize of the ſtem, acts as a ſyphon.

Fig. 2. Differs from the above only in the ſubſtitution of a trough proportioned to the whole length of a bed or border; or which, if applied to agriculture, may be ſuppoſed to repreſent a headland ditch, or carrier trench for irrigating the whole field.

Having by this means perſuaded myſelf that I am right in reſpect to the philoſophical principle, it comes to be conſidered, whether there are any, and by what means the beſt plans may be adopted for rendering this experiment more general, and obtaining a greater number and variety of reſults from divers ſoils and climates; and it ſeems to be an intereſting point of inquiry, beyond a mere horticultural application, whether this auxiliary principle may not be extended, in ſome ſhape or other, to an agricultural benefit

nefit in the mollification of harſh and thirſty lands, on the more expanded ſcale of huſbandry?

A ſcheme which has preſented itſelf to my imagination, but which I have never had an opportunity of reducing to practice, is, to obtain, in the firſt place, a command of water upon the beſt elevated level that the ground admits of; and, purſuing this level as far as poſſible with what may be termed properly, perhaps, a headland ditch, which ſhould be as nearly ſtagnant as the circulation of fluid will permit, I think one end of a ſtraw rope, proportioned to the deſign, might be immerſed in the water after the manner of my experiment, and the other be ſpun out to the length of the reſpective lands which were deſigned for irrigation, being conducted along the ridge or higheſt part thereof, by means of a ploughed trench, ſo that the moiſture might ſpread itſelf each way by deſcent into the furrows, and without the riſk of forming gullies, which too frequently happens in red lands, as is too generally proved in America, where the lands are but partly coated with graſs, and where they are ſubject to ſudden heavy ſhowers and waſhing torrents.

This

This propoſed method can, in any event, do no miſchief; but it is ſure to anſwer one good end at leaſt in the quality of manure: for when a ſtraw rope is once entrenched for the purpoſes of irrigation, it cannot poſſibly be converted to a more profitable uſe than to let it rot in the earth for a manure.

In draining, in the county of Middleſex, ſtraw ropes, of the ſize of a man's leg, have been introduced into practice for the purpoſe of keeping open the ſmall under drains. In this caſe they are found not to anſwer, it ſeems; but I conceive there is a material difference in the effect which water will produce on ſuch a drain which is to carry off a redundancy of water, and that which is deſigned to ſupply gradually a moderate demand of moiſture: the firſt caſe would, I think, be ſubject to waſh and choak, while the latter would filter into a progreſſive decay, which would tend to enrich the ſoil.

I think the improved mole plough, which is uſed with ſix horſes for forming hollow drains, might be ſo much farther amended, as to render it a fitting implement for the furrows of this kind of irrigation. I ſhould adviſe, for this purpoſe, the addition of ſuch

wings, as would turn one half of the ſod each way, to be fixed to the hind part of the plough, leaving the mole as it is, to form a ſmooth round duct like a pipe. It appears to me, however, that for either this caſe or that of drainage, this implement might be rendered more convenient by extending the ſweep of the handle down to the mole, and connecting it with the hinder part thereof by means of a thin piece of iron, fitted to the lower part of the handle with a ſocket, and ſcrewed to the mole with a nut: this iron ſhould be ſharped ſomething like a coulter, that it may not clog the plough with the obſtructing rubbiſh of ſticks, ſtraw, rags, &c. to which all ploughing is more or leſs ſubject. This improvement of the leverage would certainly give an eaſier command of the plough.

I preſume the ſame kind of other implements will apply in trenching for irrigation, which are in uſe for trenching and cleanſing drains: all theſe are to be found in Mr. Middleton's View of Middleſex, pages 291, 292, and 293. There will be found alſo a machine for twiſting ſtraw ropes, for a purpoſe very ſimilar to that which I have ſuggeſted for irrigating farms.

As

As the expence of trenching will be nearly the ſame, whether it is applied to drainage or irrigation, we may take* Mr. Middleton's rates of labour as a criterion for computation.

The prices of draining, ſays he, have been, for

Common drains, 20 pole 18 inches deep, each drain - -	0	3	0
Principal drains, 2 feet deep, of the ſame length - -	0	5	0
Burr to each ſcore - -	0	0	2

The labourer to find tools, and keep them in repair. Drains, on the Chace, are uſually made a ſhort pole from each other.

Of artificial Springs, or Mediums of Filtration for culinary Purpoſes, White-lead Works, Paper Mills, &c. &c.

Herein before we have conſidered the immenſe advantages ariſing from irrigation, in the uſe of water in a ſaturated ſtate, for the purpoſes of canals, agriculture, and ma-

* View of Middleſex, p. 293.

chinery: it is a part of our concern to diſcover and communicate what may appear intereſting to ſociety in their more immediate occaſions of houſehold economy; and in ſuch manufactures as require water in its moſt clear and tranſparent perfection. Various improvements, in theſe reſpects, have been thought of at different periods; as for example, the filtering ſtone, which has been long uſed in the Weſt Indies, and other hot climates; porous jars, filtration through cloth or paper by deſcent, mediums of leather, pulveriſed glaſs, and other ſubſtitutes for nature, which ingenuity, rather than art, has been ſtudious enough to render myſterious and profitable, without much regard to the health of the parties who were to drink the impregnated water, ſo that the ſecrets of the trade went far enough to pleaſe the eye and drain the pocket.

It ſeems to have been ultimately reſerved to Mr. James Peacock, of Finſbury Square, to employ art to the laudable end of imitating and aſſiſting nature, the only means by which men ſhould promiſe themſelves ſucceſs in thoſe hydraulic or hydroſtatic operations which involve the great intereſts of whole communities.

I have

I have the pleaſure of preſenting a print of this uſeful contrivance from the proprietor's plate, and of hoping that this little work may contribute to its becoming more generally known to mankind, who have everywhere a greater intereſt in its efficient application, than will readily occur to thoſe who are unaccuſtomed to dive into the detail of ſuch philoſophical topics; and I truſt the modeſty of its inventor, in reſpect to its non-introduction into extenſive practice, before much of the patent period had expired, will be now remunerated, to amount of the vaſt expence and labour which he has for ſeveral years beſtowed in rendering it complete, by the conviction of ſociety, and its general introduction into public works and national improvements. The annexed plate is a deſcription of the chamber apparatus, which is ſuited to the uſe of houſes, ſhips, &c. within the compaſs of twenty guineas expence. It occupies very little more ſpace than an ordinary filtering ſtone, but it is ſufficient for the ſupply of many families; and may, of courſe, be applied to the joint comfort and accommodation of a neighbourhood at a very reduced proportionate charge.

A compariſon of the account given of this invention by the inventor, with that which three Captains, of high ſtanding in His Majeſty's navy, (to whom the ſubject has been referred from the Board of Admiralty) have certified, will not only prove that the proprietor's ſtatement is free from exaggeration, but that the improvement is worthy of univerſal attention.

Mr. Peacock couches the ſuperiority of his invention, over all others, in terms which will appear very modeſt when contraſted with the official certificate, which follows them in ſtrong and recommendatory language. This machine, ſays he, 1ſt, accompliſhes the purpoſe of complete filtration by aſcent of the fluid to be purified through a medium (probably that by which nature performs the ſame operation) of pure gravel, of progreſſive degrees of fineneſs, to the minuteſt particles of ſand; by which means the fouleſt water or other fluid becomes perfectly freed from all its impurities, without acquiring any cupreous or other noxious mineral quality, which the pumice or other common filtering ſtones are juſtly ſuſpected to communicate.

2dly,

2dly, If, from continued uſe, its operation is impeded in the ſmalleſt degree, it may be completely cleanſed in one minute with the utmoſt facility; an advantage not known to any ſpecies of filtration by deſcent.

3dly, Its operation is perpetual; and, without occupying more room than a large drip-ſtone with its apparatus, it yields a pure and conſtant ſtream of more than three hundred gallons in every twenty-four hours. This circumſtance evidently puts it far above all compariſon with any filter hitherto attempted.

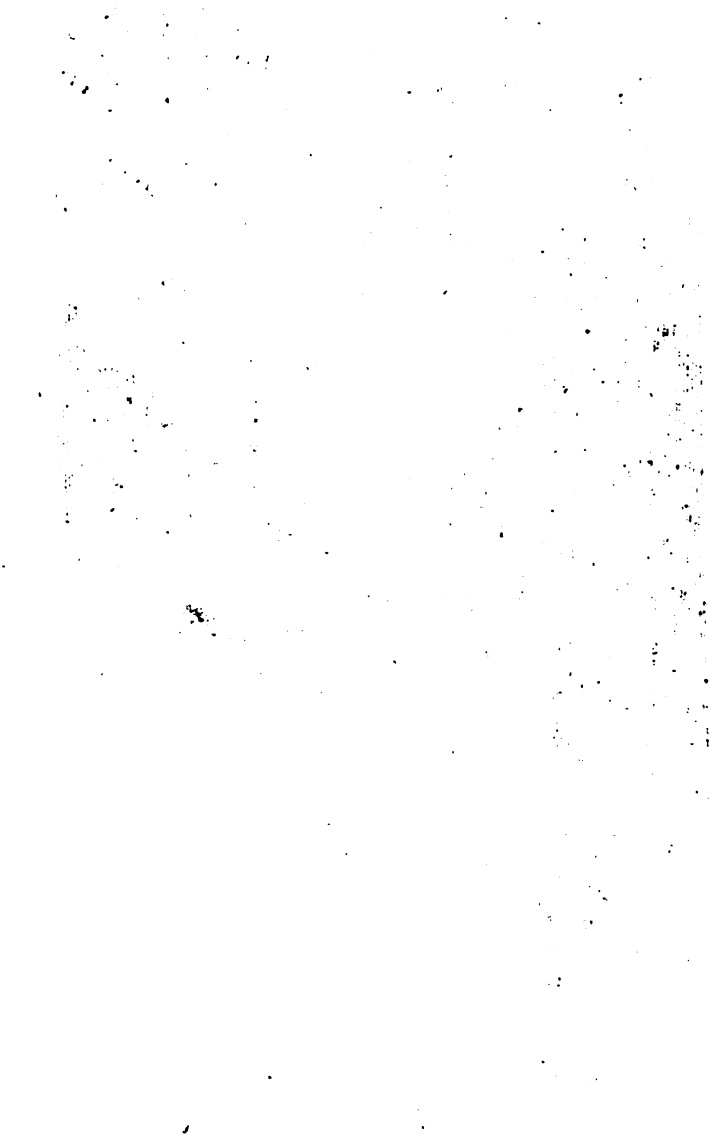
The advantages of cleanſing fluids, particularly water, ſays he, need not be enlarged upon. Clean linen, clear food, pure beverage, and the conſequent health and comfort of the inhabitants of great cities, are materially concerned; but the ſeaman, who is confined in diſtant and hot climates to the conſtant uſe of water abounding with inſects, animalcules, and a variety of impurities, which render it diſguſting and frequently noxious, muſt acquire by this means an invaluable benefit. It is with confidence, derived from long, expenſive, and repeated trials of its efficacy, that the inventor now reſpectfully offers this machine to the pub-

lic; convinced that it is powerfully and effectually applicable to promote the health, the comfort, and the convenience of mankind.

Such is the ſtatement of the man intereſted. I preſume the following independent teſtimonial will ſupport my poſition: "We the underſigned do hereby certify, that in obedience to an order of Sir Peter Parker, *Bart.* Admiral of the White, Commander in Chief, &c. &c. &c. That we have this day been on board his Majeſty's ſhip Vengeance, and cauſed the neceſſary experiments to be made to aſcertain the utility of a machine for purifying water by filtration.

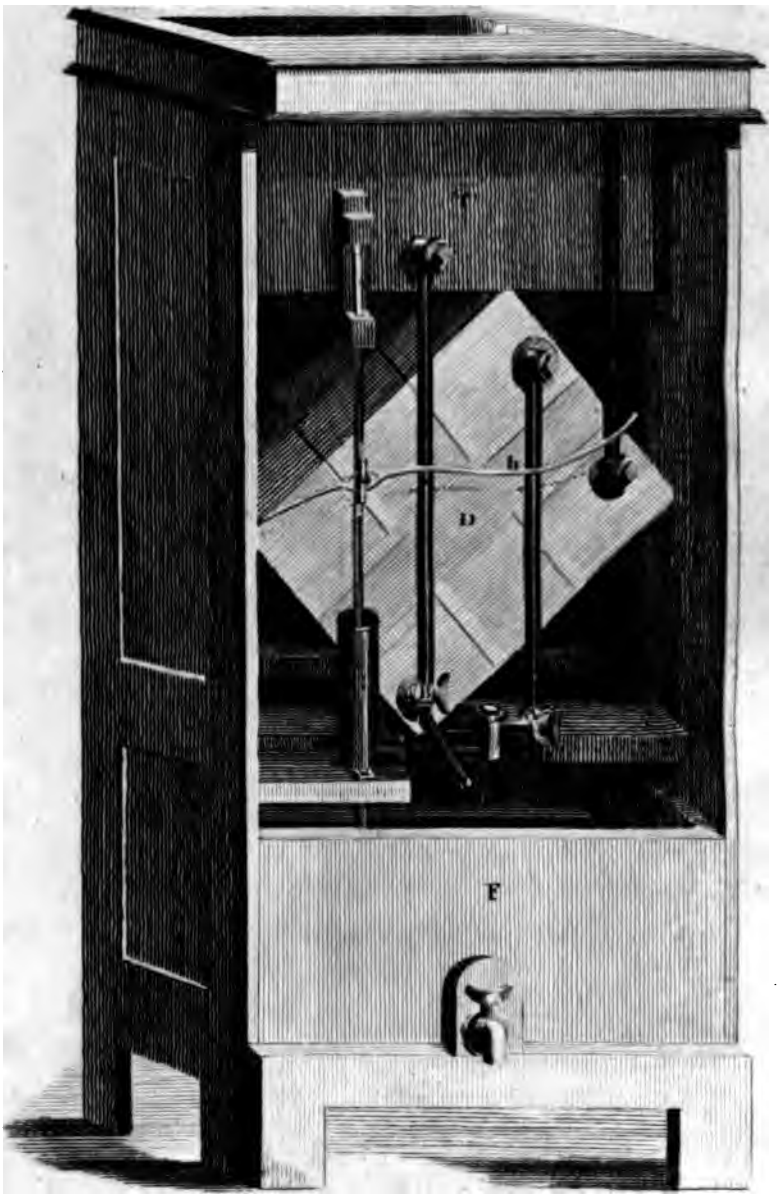
And we give it as our mature opinion, that the machine for filtration of water fully and completely performs all that the maker promiſes in his deſcriptive pamphlet of it. And that in one inſtance we found its excellence to have exceeded his report of it, for we ſaw the filtration performed at the rate of a gallon in two minutes, or ſeven hundred and twenty gallons in twenty-four hours. And we beg leave to recommend it as a moſt uſeful machine, and to expreſs our wiſh for its common uſe in the navy, particularly in long voyages,

Given



FILTERING MACHINE.

To face Page 21



Invented by James Peacock Esq.r

Given under our hands, on board the Vengeance, Spithead, July 22, 1799.

(Signed)

T. M. Russel, Capt. of the Vengeance.
Edw. Bowater, ——— Magnificent.
Tho. Larcom, ——— Lancaſter."

Mr. Peacock has added to this plate the following *Directions for uſing the Filtering Machine.*

1ſt, Let the handles of the cocks, A and B, be in a vertical poſition.

2dly, Let the upper ciſtern C, be ſupplied with turbid water, either by hand or by a ball-cock, from the main or ſome adjacent reſervoir, &c.

3dly, The turbid water will then paſs into the lower part of the filtering-cheſt D, and after expelling the air therefrom, by means of the pipe E, will aſcend through the gravel in the ſaid cheſt, and run therefrom in a purified ſtream into the bottom ciſtern F; from whence it may be drawn for uſe.

4thly, If it ſhall be intended to obtain in a large reſervoir the full produce of the machine by keeping it conſtantly in action, a pipe muſt be fixed to the ciſtern F, within two

two or three inches of the top thereof, to convey the filtered water into the ſaid reſervoir.

5thly, When the operation of the machine is ſtopped or becomes languid, the gravel muſt be cleanſed in the following manner, *viz.* Turn the handles of the cocks, A and B, to a horizontal poſition; place a bucket, &c. under the cock B; and work the pump G, by the lever h, until the water comes out nearly the colour it was of when put into the ciſtern C.

6thly, Then reſtore the handles of the cocks to their firſt poſition, and the filtration will re-commence and continue as at firſt, until it ſhall be found neceſſary to repeat the operation of cleanſing the medium.

N. B. Whenever it may be neceſſary to ſweeten fetid water by an admixture of powdered charcoal, this machine will be found very uſeful in ſeparating the charcoal therefrom when that has had its effect.

Machines on ſhipboard may be filled with the turbid water, by means of a large funnel through the apperture in the top thereof, until it will wet ten inches of a rule or ſtick put therein.

If a piece of bunting, &c. is put over the funnel,

funnel, or tied to the noſe of the cock by which the turbid water is introduced, it will keep out any very groſs matter, and thereby prevent the pipes being clogged.

In times of ſevere froſt, if the machine is expoſed thereto, it will be proper to keep the filtering-cheſt empty of water, to prevent injury to the pipes, &c.

This machine is exhibited at the Surveyor's Office, Guildhall, for inſpection and information. I have the ſatisfaction of adding that it has been highly approved by all the men of talents who have examined it:—it need not have a higher recommendation than the notice which it has received from that well-eſtabliſhed and truly worthy rural economiſt Doctor Anderſon, to whom I had the pleaſure of ſhewing it. I truſt a better approbation need not be looked for in the whole field of hydraulic ſcience.

But it is from a popular and public adoption of the ſyſtem into ſocieties of ſeveral families combined, or into incorporated and national water works, that mankind may be expected to derive the extenſive benefits which it is capable of adminiſtering. It is admirably adapted to prevent, in ſome degree, thoſe excruciating complaints the ſtone and

and gravel. It needs but an adoption to reſcue the poor and wretched from a thouſand maladies which flow from the impurities with which ordinary water is impregnated; for nature ſupplies the ſource with unceaſing bounty, and philoſophical gravitation wants only the aid of a governed direction to convey it every where without carriage: a property which is alone and peculiarly the province of fluids.

In France we learn, that an economy in the uſe of water is, in ſome caſes, a public concern in reſpect to agriculture; but it is an Engliſhman alone who turns his attention to the cleanlineſs of his food, and relieves himſelf from diſeaſe by the wholeſomeneſs of his kitchen. He is the firſt to improve the means of houſhold filtration by the contrivance of a medium which aſſimulates its functions to thoſe of nature, and furniſhes a portable ſpring which may diſpenſe a ſupply as pure as cryſtal from the rain ponds of a deſert, or the waſhings of a turnpike. In this happy contrivance he improves his bread, his beer, his ſoups, his tea, his delicacies, and his medicine: he purifies them from the filth and animalcula with which

this

this fluid element is naturally charged; and, thus ſecures his health and his longevity.

I preſume that the attention of government may extend theſe benefits ſtill farther, to the comfort and increaſe of numerous citizens. It may do ſtill more—it may adopt a general ſyſtem of national filtration, ſuch as may amply remunerate revenue by increaſing public reſources and population at a very trifling rent; and it only remains to hope that able and powerful miniſters may give theſe pacific means a leiſure moment's reflection, among thoſe which ſeem to be ſo deeply concerned in the ways and means of carnage and ſyſtematic devaſtation; and that ſuch great national undertakings may furniſh the productive means of future induſtry for the armies who are to return from the harveſt of military laurels.

Of the extent of Territory to be irrigated; the probable Remuneration which may be expected from Monies laid out in National Irrigation; and, of various Ways and Means which occur.

Hitherto we have reviewed a variety of ingenious deſigns, both at home and abroad, executed by private individuals in ſome inſtances, and by public reſources in others; and we have contemplated an infinite train of intereſting conſequences which have been, and are ſtill to be, derived from works for irrigation.

This is yet, however, an infant and limited ſcience, and it reſts with us to explore a capacious field for its future expanſion in conſidering the extent of territory which it is propoſed to irrigate, the probable remuneration from monies expended in national irrigation, and various ways and means of conſtruction which are preſented.

The data which furniſhes materials for computation in theſe reſpects, are—1. The ſtate and condition of the waſte and cultivated

vated lands. 2. The amount of annual income which the nation draws from their preſent ſtate of improvement. 3. Thoſe exiſting practical examples which afford experienced means of calculating the rational expectations of increaſe: and, 4. The ſeveral reſources which afford capacity, labour, and pecuniary means of execution.

1. The ſtate and condition of the waſte and cultivated lands of this kingdom is now tolerably well aſcertained through the medium of the agricultural papers of the nation, and the aſſiduity of certain members of the Board of Agriculture, who have peculiar merit in this grand eſtabliſhment; and whoſe general accuracy is ſo univerſally admitted, that I ſhall think myſelf authoriſed to follow their computations for my preſent purpoſe, without regard to the mathematical corrections of Mr. Beeke; and ſuppoſing an allowance upon his calculation for the hills and dales of the country.

Theſe inveſtigations ſeem to have decided a different reſult indeed from that of ſome former geographical inquiries by Templeman and others; but if they anſwer Mr. Pitt's turn, they ſhould alſo ſerve mine:— they aſcertain a much greater quantity of land

land in the iſland; and they have proved, beyond a doubt, that the ne plus ultra of agricultural and mechanical perfection is but an infant, which ignorance and ſelf-ſufficiency have miſtaken for a giant; whilſt effeminate luxury and enervated diſſipation have, with equal credulity, ſubſcribed to the deception.

It will be acknowledged, however, that points in which the greater number of reſpectable inquirers agree will be the moſt likely to juſtify computations ſuch as mine, if not to approximate truth; and on this account, as well as the ſuperiority of the documents which they have acceſs to, I have choſen to rely on the following ſtatements as coming nearer to certainty than any thing elſe which the progreſs of this inquiry has determined concluſively.

* Sir John Sinclair ſtates the lands of England and Wales to be,

	Acres.
Uncultivated – –	7,888,777
Cultivated – –	39,027,156
Total	46,915,933

* Addreſs concerning the incloſure of waſte lands, 1795, p. 7.

He

He alſo ſtates the lands of Scotland to ſtand:

	Acres.
Uncultivated – –	14,218,214
Cultivated – – –	12,151,471
Total	26,369,685

From a compariſon of theſe ſtatements it appears, that England contains 20,546,238 acres of land more than Scotland contains; but that Scotland contains 6,329,437 acres more waſte land than England contains, and is therefore far behind England in point of agricultural improvement and induſtry: for England has but little more than one ſixth part of its quantity in waſtes, while Scotland has far the greater proportion unimproved and lying nearly uſeleſs; perhaps only (to uſe Mr. Young's idea), becauſe the lazineſs of mankind is ever prompt enough to convert difficulties into impoſſibilities; and ſome have reduced it to an ideal certainty that the higher climates of Scotland are a bar againſt agricultural improvements: ſuch as the example in Forfarſhire has however happily contradicted, and left us to explore the regions of chivalry in ſearch of more ſolid ar-

guments! But Scotland has ſome conſolations that ſhould rouſe her from lethargy and ſtimulate her exertion: ſhe has more riches unimproved, and more agriculture to beſtow on her ſteril property than England has; and irrigation will be found among the moſt powerful of her means.

If we compute the improveable probability of the waſte lands of England and Wales, according to this comparative view, and by the rules which Sir John Sinclair has adopted, it will be fair and near enough our purpoſe to allow two thirds of the improveable proſpect to Scotland, and one third thereof to this kingdom.

By this method we ſhall ſtate as follows:

	Acres.
Lands incapable of improvement – – –	333,333$\frac{1}{3}$
Ditto fit to be planted –	1,000,000
Ditto fit for upland paſture –	4,666,666$\frac{2}{3}$
Ditto fit for tillage – –	1,000,000
Ditto capable of water meadow	333,333$\frac{1}{3}$
Total allowance	7,333,333$\frac{1}{3}$
Actual quantity	7,888,777

Now

Now the incapable lands are conſidered to be of no value; the lands fit to be planted at eight ſhillings per acre produce, according to the Biſhop of Landaff's calculations; the upland paſture at five ſhillings per acre rent, according to Sir John Sinclair; the arable lands at ten ſhillings per acre rent, and the water meadow at thirty ſhillings per acre rent, both according to the laſt named author.

From hence we are enabled to make at leaſt ſome kind of rough eſtimate of the improveable condition of annual income upon the waſte lands of England and Wales alone, as follows:

Rent of upland paſture	£.1,166,666	13	4
Ditto of arable land -	500,000	0	0
Ditto of meadows -	500,000	0	0
	2,166,666	13	4
			3
Multiply this by 3 for the annual produce, and it gives - -	6,500,000	0	0
Add produce of one million of acres in plantation, at 8s. - -	400,000	0	0
Proſpects of annual increaſe	£.6,900,000	0	0

Mr. Middleton has proceeded in another way to come at a ſimilar reſult in reſpect to the arable lands of South Britain. He has attempted * an eſtimate of the acres it contains, by computing the number of people employed, and their proportions of occupation in the purſuits of huſbandry; rating the inhabitants of England and Wales at eight millions.

His calculations encompaſs an immenſe field of laborious reſult, and valuable information. He ſhews the detailed ſtate of crops and appropriations, and concludes that there are but, at moſt, fourteen millions of acres in aration in England and Wales; the portions of which he rates as follows in re-reſpect to annual crops:

	Acres.
Wheat – – –	3,850,000
Barley and Rye – –	1,050,000
Oats and Beans – –	3,500,000
Clover, Rye-graſs, one Year's Ley – – – –	1,400,000
Carried forward	9,800,000

* View of Middleſex, p. 482.

Turnips

	Acres.
Brought forward –	9,800,000
Turnips and other roots –	1,400,000
Fallow – – –	2,800,000
Total in aration –	14,000,000
Hop Grounds – –	44,000
Nurſery ditto – –	10,000
Fruit and Kitchen Gardens –	50,000
Pleaſure Grounds, the unprofitable Part only – –	20,000
Paſture, Graſs Lands, and Water Meadows – –	21,300,000
Hedge Rows, Copſes, and Woods – – –	2,000,000
Ways, Waters, &c. – –	1,603,000
Cultivated – –	39,027,000
Commons and Waſtes, as ſtated by Sir John Sinclair, ſay,	7,889,000
Contents of England Wales	46,916,000

Which, according to Mr. Beake, (p. 9 of his Pamphlet, 1800) correſponds with Mr. Young's correction of Templeman.

Mr. Young has furniſhed* a detailed ſtatement of the acres in each county: I inſert it, with the buſhels of wheat per acre, and laſt year's ſcarcity where they occur; becauſe they may form a convenient table of future reference, when they are not otherwiſe in the power of the reader.

A comparative View of the Contents, uſual Produce of Wheat per Acre, as a Criterion of Quality, and of the laſt Year's Deficiency in the Wheat Crops of England:

	Counties.	Acres.	Buſhels per Acre.	Deficiency of laſt Crop.
A.	Angleſey —	200,000		
B.	Bedford —	260,000	20	6 2/3 in 20
	Berks — —	527,000	24	4 20
	Brecknock —	620,000		
	Buckingham —	441,000	21½	6 2/3 20
C.	Caermarthen —	700,000		
	Cambridge —	570,000	23½	5½ 20
	Cardigan —	520,000		
	Carnarvon —	370,000		
	Cheſter —	720,000	23	
	Cornwall —	960,000	20	
	Cumberland —	1,040,000	22	
	Carried forward			

* Queſtion of Scarcity conſidered, &c. p. 14, 1800.

	Counties.	Acres.	Buſhels per Acre.	Deficiency of laſt Crop.	
	Brought forward				
D.	Denbigh —	410,000			
	Derby —	680,090	24	5 in	20
	Devon — —	1,926,000	24½	6½	20
	Dorſet —	772,000	22½	7	20
	Durham —	610,000	21	12	20
E.	Eſſex — —	1,240,000	24½	6½	20
F.	Flint — —	160,000			
G.	Glamorgan —	540,000			
	Glouceſter —	800,000	18	8	20
H.	Hants —	1,312,500	22	6 2/3	20
	Hereford —	660,000	22½		
	Hertford —	451,000	23	5½	20
	Huntingdon —	240,000	15	7	20
K.	Kent — —	1,248,000	24	6	20
L.	Lancaſter —	1,150,000	24	7	20
	Leiceſter —	560,000	25		
	Lincoln —	1,740,000	28	8½	20
M.	Merioneth —	500,000			
	Middleſex —	247,000	24		
	Monmouth —	340,000	20		
	Montgomery —	560,000			
N.	Norfolk —	1,148,000	24	6 2/3	20
	Northampton —	550,000	24		
	Northumberland	1,370,000	27	10	20
	Nottingham —	560,000	22		
O.	Oxford —	,000	20	6 2/3	20
P.	Pembroke —	420,000			
R.	Radnor —	310,000			
	Rutland —	110,000	28		
	Carried forward				

	Counties.	Acres.	Buſhels per Acre.	Deficiency of laſt Crop.
	Brought forward			
S.	Salop — —	890,000	20	6 à 13 in 20
	Stafford —	810,000	25	
	Somerſet —	1,075,000	24	
	Suffolk —	995,000	22	8 20
	Surry — —	592,000	23	8 20
	Suſſex — —	1,140,000	26	5 20
W.	Warwick —	670,000	24	
	Weſtmoreland —	510,000	20	7 20
	Wilts — —	876,000	22	
	Worceſter —	540,000	24	
Y.	York — —	3,770,000	22	8 to 10 in 20
	Total contents	40,000,000		

As I take the materials of this table from Mr. Young's recital, without knowing the principles which guided either the calculations of Doctor Halley or Mr. Houghton, whoſe work I have not ſeen, and merely ſuppoſe it to contemplate arable land, I can form no poſitive opinion of its accuracy. Mr. Young himſelf does not conſider it to be wholly infallible; but it will ſerve the occaſion of relative proportions, and, on the ſuppoſition of Doctor Halley's having either taken the horizontal admeaſurement, or eſſayed an eſtimate of what he merely conſidered to be capable of aration, he ſeems to

to agree near enough with Sir John Sinclair and Mr. Middleton, to ſtamp their authority as a good foundation; and this baſis is ſtill farther confirmed by Mr. Pitt's adoption of this quantity, as the cultivated contents of South Britain.

Suppoſe, however, we take the amount of Mr. Young's ſtatement, 40,000,000 of acres, as the probable quantity which may derive benefit from irrigation; after deducting for the quantity of water meadow, which we may ſuppoſe to be already irrigated, ſay 5,000,000 acres. This datum will afford a net quantity of 35,000,000 acres, which we ſuppoſe to admit of water improvements by means of actual irrigation, to be hereafter introduced. But, for calculation ſake, we may ſay forty millions of acres, on a ſuppoſition of the waſte lands adding five millions at leaſt.

2dly. The amount of annual income which the nation draws from the preſent ſtate of its artificial water ways and real eſtates, with their appurtenances (perhaps excluſive of internal fiſheries, which may doubtleſs be highly improved and extended by means of national irrigation) is computed by

by Mr. Pitt, in his Report on the Income Bill, as follows:

	£.
Landlords' rents on forty millions of cultivated acres, eſtimated at 12s. 6d. -	25,000,000
Tenants' profits, at 8s. 4d. -	19,000,000
Tythes - - -	5,000,000
Mines, navigation, and timber	3,000,000
Houſes - - -	6,000,000
Annual income -	58,000,000

It will be recollected, that * Mr. Young eſtimates the people of England at twelve millions. The labour of theſe people are the riches of the nation, properly ſpeaking; but, I preſume, a ſmall portion of them only can be claſſed as agriculturiſts, irrigators, and drainers: if more of them were employed in theſe purſuits, it would ſoon reſult in accumulated income and domeſtic happineſs.

* Conſiderations on the Queſtion of Scarcity, 1800, p. 17.

Mr.

Mr. Young* ſuppoſes that three millions of the people of England are employed in its agricultural purſuits; and that theſe three millions feed ten millions from the culture of thirty millions of acres. In this ratio, ſeven hundred thouſand perſons more would cultivate the ſeven millions of acres of waſte lands which are ſaid to exiſt in England and Wales, in a more impoveriſhed ſtate, I apprehend, than that which nature preſented them to the occupancy of man. Now if theſe lands were only raiſed to the medium produce of thoſe cultivated lands of the kingdom which are in a ſtate of aration, without eſtimating extraneous improvements, they would almoſt add the whole of the following ſum to the annual income of the nation; for a ſmall part indeed is at preſent productive:

	£.
Landlords' rents on ſeven millions of acres brought into a ſtate of culture, at 12s. 6d.	4,375,000
Tenants' profits, at $\frac{3}{4}$ -	1,093,750
Tythes, at $\frac{1}{5}$ - -	875,000
Increaſe of income from the culture of waſte lands, without irrigation - -	6,343,750

* Conſiderations on Scarcity, 1800, p. 76.

This ſtate of culture, according to * Mr. Young, would feed 2,333,000 people; that is, 1,630,000 perſons more than what would cultivate ſuch an extent of territory, might be fed by it at home, if the arrangements of domeſtic economy would make their native ſpot more intereſting and certain to them than the inducements to emigration. But, it is preſumed, that irrigation might do much in addition to this; beſides, its capacity to afford immediate reſources from future proſpects. It is certainly a neglect that we ſhould greatly lament, and a deficiency which we ſhould ſpeedily ſet about to remedy, when we reflect that waſte lands in Weſtmoreland are rented at a penny an acre for the ſtarvation of ſheep †; while the attentions of agriculture, irrigation, and drainage might ameliorate their ſoil; coat them with warm manure; improve their climate; facilitate their conveyance; bring many new reſources to market; cover them "with numerous herds and flocks; cauſe them to

* See Conſiderations on Scarcity, &c. 1800, p. 76.

† See the Agricultural Report of Weſtmoreland, or the recital thereof in Sir John Sinclair's Addreſs concerning Incloſures, 1795, p. 5.

wave

wave with luxuriant crops of grain;" clothe them with general verdure, and adorn their ſummits with ſtately foreſts.

3dly. Thoſe exiſting practicable examples which afford experience and means of calculating the national expectations of increaſe, through the medium of irrigation alone, have been curſorily reviewed in our progreſs through this inquiry.

It follows, to collect a few of the facts to a focal point of recapitulation, that we may take proofs of what has been done and perfected in various inſtances and countries, as the beſt aſſurance of what may be performed in this by a perſeverance in ſimilar operations.

*The richeſt arable land in the vale of Pia, in France, ſells at 20l. 9s. 6d. per acre, if not watered; but if watered, it ſells at 37l. 9s. 10d. per acre. This is a difference of 17l. 0s. 4d. per acre in the value of lands, which is to be placed ſolely to the credit of irrigation.

At Campan, lands, having water at command, ſells at ſix hundred livres the journal (49l. 17s. 6d. per acre) of 700 cannes (about 19,600 feet); but not watered, from 300 to

* See p. 211, or Young's Tour, p. 364.

400 livres. This ſeems to place to the credit of irrigation a ſum equal to half the value when the improvements are made on the inferior priced lands of 300 livres value per journal of 700 cannes, and muſt be called a gain by irrigation of 24l. 18s. 9d. per acre.

At Falaiſe, a vale of watered meadows produces annually 3l. 10s. per acre; but we have not here the ſcale of compariſon.

At Montelimart, an acre cloſe to the town lets at 120 livres (6l. 2s. 6d.) per acre; but a diſtance off at 60 livres. This is a difference of 3l. 1s. 3d. per acre per annum, which ſeems to flow from irrigating the land with the liquid manure or waſhings of the city.

At Avignon, watered meadows ſell at 76l. 10s. per acre near the city: at a diſtance from it they ſell at 61l. 5s. per acre. This is a difference of 15l. 5s. per acre gained by irrigation.

In Provence, canals are contrived for irrigating at public expence.

Thus the averaged credits of irrigation in the ſeveral examples which we have drawn from France may be ſummed up as follows:

To

To the credit of irrigation, under the head of *value*;

	Value gained per Acre.		
Vale of Pia - - -	£.17	0	4
Campan - -	24	18	9
Avignon - -	15	5	0
3	58	4	1
Average in favor of irrigation, and gained in value per acre	£.19	8	0

Which increaſed value, rated at twenty-four years purchaſe, gives an increaſed rent, flowing ſolely from irrigating theſe lands, of 16s. 2d. per acre.

To the credit of irrigation, under the head of *rent*, ſpecifically ſo ſtated;

	Rent gained per Acre.		
At Montelimart - -	£.3	1	3
Average rent at 24 years purchaſe, as above - -	0	16	2
2	3	17	5
Mean gain of rent per acre by irrigating rich town and medium country lands	£.1	18	8½

Brought forward	£.1	18	8½
According to Mr. Pitt's method of computing income, add,			
Tenant's profit, at 3-fourths	0	19	4¼
Tythes, at 1-fifth - -	0	7	8¼
Average produce per acre, gained by irrigation -	£.3	5	9

In England, we have ſome proofs which afford data from a few examples of poor lands raiſed by culture to a ſtate of high cultivation. The lands near London were formerly nothing but moors in the neighbourhood of Finſbury, and little better in Mary-le-bone: they are now in a ſtate of culture affording ſuch extraordinary profits, as to render them an exception to a general rule of ſafe calculation; yet theſe lands are capable of accumulation from the helping hand of the irrigator. But we have nevertheleſs a few caſes in the country which afford reaſonable grounds for a national concluſion.

Mr. Middleton, ſpeaking of the New River, or Sir Hugh Middleton's canal, ſays that

that it has probably trebled the value of many thouſand acres through which it paſſes *.

† The produce of meadow land in this county, ſays Mr. Middleton, is 10l. an acre per annum; of the arable land, in common fields, 8l.; light land incloſed, 13l. Any of theſe lands would produce, he ſays, 15l. if watered meadow §.

Say thus, meadow land	£. 10	0	0
Arable - - - -	8	0	0
Light incloſed - - -	13	0	0
3 | 31	0	0
Mean produce per acre	£. 10	10	0

This ſum, taken from 15l. for watered meadow, puts 4l. 10s. per acre per annum produce to the credit ſide of irrigation.

* View of Middleſex, p. 403.—† Ib. p. 317.

§ Three crops, at 1½ load, is 4½ loads,

which, at 3l. only, is - -	£. 13	10	0
Other feed - - - - -	1	10	0
	£. 15	0	0

* Mr. Templer, of Stover, in Devon, uſed to rent out lands at 10s. per acre; he has raiſed them, by means of irrigation, to 2l. and 3l. per acre. This is an increaſed rent of 2l. 10s. per acre per annum, and an increaſed produce to the credit ſide of irrigation of 4l. 7s. 6d. per annum.

In the county of Weſtmoreland, rights of common for ſheep are ſaid to be let at ſo low a rate as to return only a rent of 1d. per acre for the land; which, at twenty-four years purchaſe, makes the value of the property 2s. per acre. The farmer's rule for eſtimating produce on arable property would make this 3d. per acre produce: and the common right of lands in Wales, under the ſame predicament, at 4d. rent, would yield 1s. per acre per annum produce; yet it is doubtful whether ſtarvation and contingencies do not undergo this. Taking thus two of the higheſt and two of the loweſt examples in the kingdom, and ſuppoſing the latter to draw only half the benefit of improvement from irrigation that is demanded, to bring it to Mr. Pitt's medium of 24s. 4½d. per acre per annum produce throughout the kingdom,

* See page 176.

we

we ſhould meet half way between this gain of 12s. 2¼d. per acre produce gained by irrigating the waſtes, and the higheſt medium of gain by irrigating which we collect from Mr. Middleton's computation of the Middleſex water meadows, compared with Mr. Templer's actual improvements in the county of Devon, made ſolely by means of irrigation.

In this view, the account of gain by irrigation alone, would ſtand as follows:

	per annum per acre produce.
Gained by irrigating Middleſex meadow - - -	£.4 10 0
Ditto, by Mr. Templer, in Devon - - - - -	4 7 6
	2 | 8 17 6
Higheſt medium produce gained per acre - - -	£.4 8 9
Say thus; higheſt gain by irrigation - - -	£.4 8 9
Loweſt medium gain by ditto	0 12 4¼
	2 | 5 1 1¼
Mean gain of produce by irrigation - -	£.2 10 3½

Which is yet 15s. 5d½. per acre ſhort of the gain which irrigation has actually afforded in France, according to the exiſting facts which are teſtified by Mr. Arthur Young; whoſe long experience, ſkill, and official dignity, render his evidence concluſive.

Hence we deduce a ſcale for aſcertaining the mean value per acre of water when applied as a manure; and as this is perfectly independent of the moiſture afforded during the continuance of natural ſhowers, and ſhould, by every poſſible means, be treaſured up from every ſource, ſo that it may be diſpenſed with an uniform hand through every droughty ſeaſon, in the juſt proportion which the functions of vegetation requires, it of courſe applies to every acre in the kingdom, whether high or low, which can be brought into a ſtate of cultivation by art.

But that I may not be complained of for exaggeration, which may very naturally be expected from men who are not accuſtomed to think and calculate upon a national ſcale, I will compute the probable gain on an equal number of acres to that of the actual cultivation which Mr. Pitt has adopted as a baſis for the income tax; leaving others, however, as well as myſelf, to make future

practicable

practicable deductions, as they may be found expedient, from this approximate datum of moderate allowance and rational poſſibility.

Say then that the poſſible gain upon forty millions of acres, contained in England and Wales, might, by means of water manure applied at ſuitable ſeaſons, yield an increaſed produce of fifty ſhillings per acre, and it proves the locked-up reſources of the nation to amount, in the ſingle item of irrigation by way of manure, (without calculating its various other uſes in the buſineſs of irrigation, watering cities, turning mills for a thouſand kinds of labour-ſaving machines, feeding fiſh ponds, pleaſure fountains, baths, moats, daries, ſtables, farm yards, dye houſes, breweries, tan yards, &c. &c.) to the ſurpriſing ſum of one hundred millions per annum.

Now ſuppoſe the national attention to be awakened to only one tenth part of this extent, or that one acre in ten were to be brought into a ſtate of irrigation, it would greatly overgo the amount of ten millions of pounds income per annum; becauſe, in this caſe, the moſt ſuitable lands for the higheſt improveable condition would not only be choſen for the ſcite of operation, but the charges of elevation and diſtribution would

be ſunk to about the level of the new river canal, and the greater proportion of the annual expence woul be abſorbed in the reduction of height and mains.

It will be recollected that I have computed the annual expence of a national main, &c. at one and a half millions for an extent of fifteen hundred miles upon national account, as a mere regulating waterwork, which would at all times, I think, be ſufficient to ſupply the ſurplus demanded for regulation; and, is probably a liberal allowance for diſburſements, which can only be ſtated at an approximate computation.

Engineers will readily perceive that *this* idea is intended as an average which is ſuppoſed equal in expence to the detail of open and cloſe work, ſmall and large pipes, canals, baſins, regulating locks, reſervoirs, air-veſſels, ſafety-valves, &c. which items could only be preciſely aſcertained by an accurate inveſtigation, and by profeſſional means. And it will be alſo underſtood, that I do not mean this work to interfere with individual rights, or with their works; I only mean that the nation ſhould undertake to ſupply its never-failing reſources to the full extent of all its demands, and to the comfort and

advantage

advantage of all its ſubjects, who would be thus furniſhed with the ample means of paying a moderate rent for ſuch an endleſs bounty by the profit of converting it to their various occaſions.

Neither do I mean that the national purſe ſhould be touched for the means of execution. In the idea there certainly reſts a public property in reſerve, which is yet untouched, and may be amply uſed to the advantage of all men: I will not preſume to dictate ways and means—I will only ſuggeſt them. I have no doubt of the national right, and I think the ſpeculative property an object of infinite profit. The day is not far paſt when the caſh of Amſterdam would have ſeen day-light upon ſuch an occaſion; and, if the national faith and ſafety is no ways lowered in the opinion of the commercial world, I think the conjecture would prove real that the ſame gold and ſilver which formerly ſhined in coin, would again make its appearance in a more profitable way than in the melting pot of a goldſmith.

Whether, however, the nation ſhall draw from this reſource a clear annual production of five millions, or one hundred millions, ſeems to reſt entirely in their ſpirit and at-

tention to the ſubject; for there appears to be little, if any doubt, that the ſingle reſource of irrigation is fully competent to this ſupply.

It will probably be objected, that I have allowed too ſmall an eſtimate for annual expence. I admit it: theſe things are to be taken into a comparative glance, which can only be caught by the eye which is accuſtomed to explore them; and when it is conſidered how many great productive branches are untouched in this computation; (not to ſpeak of their infinite generative relations), it will be found to end about the ſame mark, and will produce always in proportion to the quantum of the means that are employed.

If the nation were to take upon them the univerſal operation of all the water works in the kingdom, I grant it that ſome millions per annum muſt be added to the account of diſburſements; but when it is conſidered that immenſe works of this nature are already in exiſtence, and maintained at the ſpeculative expences of individuals who reap high profit from ſuch, it will be alſo ſeen that theſe would form improved branches of the national ſyſtem, and that innumerable ramifications would be added throughout every

every acre of the iſland, promiſing ſimilar gains to the ſpeculator, annual rent to the national works, and ſtill greater ſuperiority to the agriculture, manufactures, and commerce of Great Britain.

When we recur to former computations on the culture of the *larch tree, in the ſyſtem of irrigation for the Northern Counties, where there is abundance of waſte land, what may not be inferred from it? It affords a production of itſelf which co-operates to render agricultural irrigation of great and eſſential uſe. But it does more than this in reſpect to the larger arteries of irrigation: it facilitates the immediate conſtruction of valuable canals, on the credit of thoſe future productions; and it thereby opens the road to riches through the means of agricultural irrigation, ſea ſand, and other manures, while it every where ſpreads culture and population, and returns its reſults to the mutual advantage of water conveyance and the increaſe of interior wealth. Nor are theſe counties alone in regard to particular advantage; for moſt other parts of the kingdom afford ſome peculiar ſubject for facilitating the avenues to irrigation.

* See p. 238 to 251 herein before.

In

In computing the expence of raiſing a ſupply of water to a perpendicular height of nine hundred feet, and of diſtributing that water perpetually through a twelve inch main to the extent of fifteen hundred miles of national ſummit level, it will be remembered that the ſum allowed, at a full practicable price, amounts to an annual one million and a half. At the ſame extreme allowance of rate it may be admitted, that by combining the force of the elevating machinery ten times that quantity of water may be continually diſtributed in the ſame manner; more eſpecially as there would be a ſmall degree of expence only attached to the repetition of baſin work, regulating locks and reſervoirs. If we admit the probability of what it ſeems reaſonable to ſuppoſe, that one third of this elevation would, at an average, encompaſs the powers of diſtribution, then it follows that ten millions of pounds per annum would extend thirty ſuch regulating mains; which is perhaps equal to all the ſprings which feed the Thames put together. Let an agricultural, manufacturing, and commercial nation contemplate an idea (which, however romantic at firſt ſight, is practicable), of placing an artificial

tificial river, of conſiderable dimenſions, upon the dividing ridges of the country; having its ſources fed from the mountain ſummits; turning mills and machinery by its mechanical powers throughout all the precipices of its deſcent; filling navigable canals throughout all the numerous roads of interior commerce; diſpenſing the benefits of pure and wholeſome water into every kitchen and dairy in the kingdom; wantoning in all the ſportive fountains of innocent pleaſure; multiplying the means of ſupporting man from the diſtributive increaſe of the finny race; irrigating the thirſty ſoils of gardening and agriculture, and increaſing the human kind by the multiplication of their comforts and ſupply. I ſay, let ſcience contemplate theſe reſults, and ſhe would probably find the aſtoniſhing addition of one hundred millions income per annum a very moderate allowance!

But I mean not to run the works to the extent of the diſburſements which I have eſtimated; for there are many cheaper means which can be applied to the purpoſe of collecting water into the reſervoirs: for inſtance wind-mills, ſuch as work without attendance whenſoever the wind blows, or

at

at whatſoever point of the compaſs, afford a cheaper power to greater extent; many ſtreams and ſprings lay high enough to be conducted by trenches along the ſides of the hills and mountains as feeders to the national ſtreams; the deſcending rains may be collected in the ſame way by catch drains: and many of the boggy ſummits may be ſo ſapped and drained as to draw from their interior ſprings a very material ſupply, while much more may be raiſed from wells dug in elevated ſituations and diſcharged by chain pumps. Lifting wheels of various deſcriptions may be ſucceſſively applied to return a conſiderable part of the deſcending ſtreams into canals upon a higher level; but, there is one exiſting ſource of conſiderable power which might afford a rent to the proprietors as an auxiliary to the national works: water might be conducted to every working ſteam engine in the kingdom, and a little additional expence might enable each to huſband its ſpare time to the uſe of national irrigation.

4. The ſeveral reſources which afford capacity, labour, and pecuniary means of execution, are neceſſarily ultimate conſiderations to induce us to act upon our own conviction; and, although a non-productive ſtock-

ſtock-jobbing habit of miſtaking the ſkin for the carcaſe, will be by this time expecting from me its very prompt *cui bono* of ſuperficial arithmetic, men of deliberate reflection will very cheerfully accompany me a little farther on the road of impreſſive illuſtration and ſolid example; for thoſe who undertake to think ſeriouſly for their country's good, and ſeek to lay a permanent baſis of finance, will agree with me, that to ſupply an increaſed ſum of repreſentative revenue into the public coffers, and to leſſen its demands to an equal amount by fiction, are one and the ſame thing in appearance, and may be oſtenſibly laudable; but, to furniſh productive means to the nation by the culture of its latent and permanent reſources, intrinſically interwoven in the web of common gain and proſperity, is a diſtinct conſideration which leads ultimately to the death of unpopular taxation, and calls for the cooler moments of reaſon to explore the relative connexion of men and things, and the mutual ties of intereſt between government and her people.

In this progreſs of inveſtigation, I always think it a duty to ſociety to bring forward the moſt incontrovertible arguments which occur

occur to me; and where I find ideas that have been originally the reſult of my own reflections, even at a very diſtant period back, and which prove alſo to have occupied the thoughts of tranſcendant merit and talents, I feel no inclination to mutilate the ſuperior language in which I find them clothed, in order to reap the credit of another man's labour, or to deprive the community of thoſe ſtrong and impreſſive points which fall with double effect into the ſcale of their intereſts when they have been previouſly committed to paper by the pen of a more able author. In this view I have on former occaſions found peculiar pleaſure in ſurrendering the palm of diſtributive labour to the writings of Adam Smith, as I now have equal ſatisfaction in acknowledging the ſuper-excellence of Doctor Anderſon's reaſoning on domeſtic economy, the ſaving of animal labour, and the multiplication of national wealth by the improvement of mechanical powers.

It will be recollected, that by way of approximate eſtimate through the foregoing parts of this work, I have confined my computations chiefly to the extenſion of a principal national artery or main for communicating

municating water from the higheſt ſummits of the country to the reſpective regulating baſins and reſervoirs, and from one reſervoir to another; ſo that, in caſe of any and every emergency, a ſufficient head may be given to any part which may prove deficient through caſual waſtage or partial drought: and all this part of the operation I have calculated, as a public right and undertaking, by the help of machinery for raiſing the water (even 900 feet high at the greateſt poſſible expence) from the tides, lakes, and rivers, whereſoever any of them may afford an eligible ſite for transferring this inexhauſtible reſource of water from its natural lower level to a ſummit of elevation, from whence it may act in its courſe of deſcent by the mere effect of its own gravity.

It does not follow that I adviſe Government to be inattentive to the increaſe of mains, which may afterwards be required, or thoſe more eaſily-commanded ſources of irrigation, which the principles of natural philoſophy have conſigned to its pre-emptive occupancy and profit; nor would I be underſtood to deviſe the means of a progreſſive monopoly of this fluid element, for the excluſive purpoſe of public irrigation; thereby creating

[illegible] under's apprehension correct, and [illegible]

I would have the competent capacity of the kingdom employed in husband every power of man and steam above the levels of the natural rain and in several branches, as a supply for the various gradations of individual employment throughout the whole extent of territory; having every man to enjoy the benefit of his own rights, in his own way, with the least possible interference of the public works, yielding on all sides compensation for unavoidable injuries; and with this reflection only, (a construction which I apprehend to be inseparable from the silence and security of private property, and overal with the distinction of *mean*) that he who would not employ that talent, over which the existence of social compact had given him a preference, on this implied condition, that he should so employ it, as to do neither overt nor negative injury to others, should feel the penalty of reversion to the common interest of the community.

I should in every case be less tenacious in respect to the specific application of the mean profits which might arise from lucrative works, than of that principle of general

ral accommodation from which every member of the community derives an inherent right to the extenſion of expedient improvements for the public good.

In this view of the ſubject, it will not be ſuppoſed that I mean to ſhut up canals in caſt iron water pipes, or to run ſo mad after a ſyſtem of ditching and locking, as to overlook the advantages which may flow from a combination of their powers: numerous would be the inſtances in a national water-work, where ſmall canals would perform the transfer of a mountainous country with great profit, and at the ſame time feed the ducts of agricultural irrigation; nor would the inſtances be leſs frequent where the water-pipes would form a ſyphon, acting from ſome more elevated reſource to ſupply alternate ſegments of a canal of unequal heights, where the ruggedneſs of a country rendered an unvarying level (which ought to be our ſtanding maxim) a downright impoſſibility. Often, indeed, would the caſe occur, in a country of this deſcription, where an inclined plain might join the continued line of communication over a valley, where the eaſieſt means of obtaining water would be through a combination of

the two powers, by laying a pipe of communication with the foundation of the rail-way.

Dr. Anderſon, in his View of the Agriculture of Aberdeenſhire, has done ample juſtice to thoſe facilities of national transfer and locomotion which are effected by turnpikes and canals; nor has he omitted to intimate, in ſtriking proofs and colours, the infinity of happy reſults which have everywhere ariſen from a due attention to their extenſion into the moſt barren territories which were known to our anceſtors, and which their darkneſs and prejudices had ſtamped with the brand of impracticability in the miſt of popular perſuaſions.

The beautiful compariſon of ſimple facts which Dr. Anderſon has choſen, will, I hope, have a happy tendency in awaking the thoughtleſs from a moſt injurious lethargy, and in rouſing the manly dignity of the antient Briton from the effeminating ſhackles of a faſhionable inſignificancy. Nothing perhaps can have a more ſtriking effect upon a popular mind, which ſeems to have nearly loſt itſelf in the labyrinth of operas, routs, galas, and nightly theatres, than the cheriſhing proſpect it muſt behold itſelf

itſelf extricated to the enjoyment of, in contemplating the progreſs of arts from the dawn of untutored invention; the progreſs of ſcience from a rude hieroglyphic; the progreſs of agriculture and commerce through the dreary waſte, the uncultivated deſert, the trackleſs courſe, the cheering footpath, the accommodating cartway, the facilitating turnpike road, and the ſtill more wonderfully powerful canal. It is to theſe indeed, and to the inventive genius of thoſe who contrive labour-ſaving machines, that mankind owe moſt of their comforts and treaſure; that commerce and navigation owe their proſperity, and cities their aſtoniſhing grandeur!—But it is time to recur to plain, ſimple facts, which need neither type nor flower of illuſtration.

* "The object of roads," ſays Dr. Anderſon, "can never be brought too often under view where improvements are propoſed, becauſe without having good roads, every exertion in other reſpects muſt be clogged with difficulties that are inſurmountable, and no progreſs can ever be made.

* Report to the Board of Agriculture on the Rural Economy of Aberdeenſhire, in 1794, p. 219.

"I am old enough," continues the Doctor, "to remember the firſt turnpike act that was obtained for Scotland; and I recollect the time when a carriage of any ſort upon wheels, on the road between Glaſgow and Edinburgh, was ſuch a rarity, that the whole people in a village went out to look at it, and the children would have followed it for a mile; and now the intercourſe between theſe two places along the ſame road is ſuch, that carriages paſs every minute. What has been the conſequence of it? The produce of every farm can be carried to market at one-tenth part of the price they formerly could be. Manures can be obtained in great quantities to many farms eight or ten miles from Edinburgh, where not an ounce could ever have been brought. A ſpirited cultivation of the ground has taken place inſtead of the languid torpor of former times: the fields are much better managed than formerly, with leſs than half the beaſts of labour. The rent of land is nearly trebled; and the tenants are univerſally more wealthy in every reſpect than before. At the diſtance of twenty miles or more from Edinburgh, where, by reaſon of the badneſs of the climate, the poorneſs of the ſoil, and the

the want of markets, the grounds were as effectually locked up from the plough as if they had been bound up by an everlaſting froſt: a market being now brought to their doors for corn and hay to ſupply the numerous horſes, and other kinds of neceſſaries for the people who travel the road, proviſions for thoſe who afford them accommodation, and for the numerous artificers who are wanted to ſupply the neceſſaries they ſtand in need of, and the people who are conſtantly employed in making roads, repairing carriages, building houſes, and other neceſſary operations, means have been put into the hands of the occupiers to cultivate their grounds; in conſequence of which the unfavourableneſs of the climate has been ſurmounted, the barrenneſs of the ſoil corrected, and extenſive fields are now under cultivation, and bearing abundant crops, which, if the former ſtate of the roads had continued, muſt have remained barren heaths to the end of time.

The people in every country diſtrict, where turnpikes have not been erected, look upon them with ſome degree of averſion, as the money paid at theſe toll bars appears to be a burden on thoſe who pay it: and thoſe

in towns are ſtill more outrageous againſt it, becauſe they think the money there paid muſt be added to the price of the commodities they are to conſume, and muſt ultimately land upon them. They do not advert to the diminiſhed price of carriage, which will be a conſequence of theſe turnpikes, and which bears no proportion to the toll. For example, at the period alluded to, all coals were brought into Edinburgh on horſes' backs: a horſe-load at that time was two hundred weight. All coals are now brought in carts, and there are ſome of theſe coal-drivers who now bring twenty-eight hundred weight in a cart drawn by one horſe: for this he pays twopence halfpenny of toll; ſo that he brings what would have employed twelve horſes and ſix men for twopence halfpenny. The ſaving here is ſo enormous, that if it had been mentioned *a priori*, it would have been declared to be impoſſible; but the facts are inconteſtible; and though they could not be foreſeen, they are now felt on the univerſal increaſed proſperity of every claſs of people; many of whom, while they feel its influence, are unable to trace the beneficent cauſe from whence it flows."

I ſhall

I ſhall pay ſome degree of reſpect to the ways and means which have occurred to this ineſtimable and accurate obſerver in the affairs of rural economy, in regard to what concerns the conſtruction of turnpike roads; for every ſaving in theſe concerns will apply ſtill more forcible to the conſtruction of canals, which are ever to be conſidered as a ſuperior degree of public ways, rendered more infinitely competent to all great operations in conveying heavy burdens (even in a fifty-fold degree) at a very reduced expence, without conſidering how much more money is required to amend the daily cutting of carriage wheels; or computing, on the other hand, the various items of irrigation to which this very great facility of conveyance will convert every ſurplus drop of water, without incurring an additional charge. Yet it is wonderful to obſerve the very general averſion of that commonality, who are the moſt burdened of any perſons for want of ſuch, to an extenſion of theſe great national improvements on ſuch productive principles, which adminiſter comfort and plenty to the moſt needy at reduced prices, in lieu of poverty and extortion.

"There is no popular prejudice I ever met with," ſays this ſame author*, "that is ſo unreaſonable as that which prevails againſt turnpikes. In moſt other caſes the people are anxious to throw all public burdens upon the rich rather than the poor; but the caſe is directly reverſed in this inſtance. The roads are all made where no turnpikes exiſt, by the labour of the poor, for which they receive no payment; many of whom have neither horſes nor carriages ever to travel on theſe roads: but the rich, in conſequence of that labour, are enabled to loll in their carriages at their eaſe; and while they are *thus* cutting up the roads, contribute nothing to put them in repair. A turnpike act, (and conſequently a canal act, for that is to be conſidered as a ſuperior ſpecies of turnpike) which ſubjects theſe perſons and others who are to uſe the roads, to a tax to put them into repair, is obviouſly the moſt equitable plan for making the roads that ever could be deviſed, and ſhifts the burden, in the firſt inſtance, from the ſhoulders of the poor to thoſe of the wealthy. One would imagine

* Rural Econ. of Aberd. p. 132.

that

that a turnpike act, on this principle, ought to be univerſally a very popular thing."

Dr. Anderſon recommends, as a mode of expediting theſe great public undertakings, that a ſufficient ſum of money ſhould be borrowed, upon a mortgage of the premiſes, to complete the works intended at once; to begin neareſt to the town, or point of production; to ſuffer no money to be diverted from the purpoſe deſigned; and that if any difficulty ariſes in borrowing the money, the gentlemen of the diſtrict through which a line of communication is to extend, would do well to conſult on the riſk and propriety of warranting the tolls to the amount of the intereſt of the money borrowed, by the joint ſecurity of all the perſons intereſted in ſuch line; any deficiency, in caſe of neceſſity, to be aſſeſſed upon each individual, ſo binding themſelves in proportion to their valued rent: they themſelves, in that caſe, to become creditors on the undertaking, to the amount of ſuch advances, if ever they ſhould happen, to be paid when the ſtate of the tolls permitted it. The reaſoning which applies to this kind of ſecurity, with the advantages to be expected from it, are both of them obvious.

The

The following ingenious remarks, on the importance of keeping a level in the conſtruction of roads, are made by the ſame author*:

"In every line of a turnpike road the ſtricteſt attention ſhould be paid, ſo to line out that road, as to keep it as nearly upon a level plane as poſſible; and that in laying out theſe roads, every other conſideration ſhould be made to give way to this one. The inconveniences that reſult from pulls on a road begin already to be felt; and every day's experience will tend to put this article in a more and more conſpicuous point of view. At preſent, every one feels the neceſſity of avoiding great pulls, but few have their minds ſufficiently impreſſed with a conviction of the infinite importance of ſmall pulls. When they conſider, that if the roads be once made firm and good, ſo as to admit of carriages going at all ſeaſons of the year with a ſingle horſe only, that horſe may go with eaſe upon a level road with a load, which he could not, without overſtraining himſelf, move at all up an acclivity, even of one inch in a yard: it muſt follow, that if ſuch acclivities frequently oc-

* Rural Econ. of Aberd. p. 134.

cur

cur, an univerſal diminution of ſeveral hundred weight on each load that is to be carried along them muſt take place; and if we were to attempt to make a computation of the loſs that would be thus ſuſtained by the public, it would amount to ſomething that approaches ſo near to infinity, as to appear incredible. For it is to be remarked, this loſs ſhould be made to comprehend, not only the amount of carriage of the ſurplus quantity on what is actually tranſported, but alſo the total value of things which might have been carried, and which, becauſe of this additional expence, muſt be allowed to go to abſolute waſte where they now are: for there are many articles which might be uſeful in arts and commerce, that might find a very extenſive ſale, if they could be afforded at a ſpecified price, but which, if raiſed the mereſt trifle above that, can never find a purchaſer at all. I muſt therefore beg leave to repeat it, that this is a matter of ſuch great importance, that almoſt no other conſideration ſhould ſtand in its way."

After making theſe and ſimilar intereſting remarks, the Doctor adds, "Every argument that can be uſed for the making roads, applies with ſtill greater force to the making of

navigable canals, wherever the ſituation is ſuch as to admit of them *."

But he wholly depreciates the mode which hath hitherto been adopted for raiſing the funds that are to be employed for conſtructing canals, as the worſt that can poſſibly be conceived, as being uneconomical, unneceſſarily burdenſome to the public, as well as its being calculated to defeat the intent, to ruin the firſt adventurers, to promote a ſpirit of gambling and ſpeculation, which ultimately terminates to the advantage of unconcerned purchaſers, who have avoided the burden of the undertaking, while others have ſunk under the weight of procraſtination and ill-managed difficulties. In ſupport of this opinion, he gives two ſtriking inſtances: the firſt in the caſe of the Forth and Clyde canal, which, after a long ſuſpenſion of competent remuneration, returned thirty per cent. upon the very ſhares which had been ſold out through diſtreſs; and the other in the caſe of an old canal in Yorkſhire, which returned 500l. per annum to the ſpeculative purchaſer of ſhares, which coſt

* Rural Econ. of Aberd. p. 136.

only

only 50l. under ſimilar embarraſſments of depreciation.

Theſe facts, he concludes, need only to be ſtated to ſhew that the whole ſyſtem is radically defective; and not only is productive of private diſtreſs, but is alſo ſubverſive of the intereſts of commerce, for the benefits of which they were formed; and that, therefore, it ought to be departed from.

There is, however, one plan which ſtrikes Doctor Anderſon's mind as an effective one, through the happieſt reſult of experience in ſeveral ſimilar caſes in this kingdom *. "It is ſimply," he ſays, "to raiſe the money for making canals, which are literally public roads, after the ſame plan as for making turnpike roads:—that of mortgaging the toll duties to be levied from them to procure money for making them.

"There is only," he continues, "this difference between roads and canals, that a

* Two caſes are cited in ſupport of this plan, *viz.* the building the bridge of Perth with money borrowed upon the tolls, which was ſoon remunerated and free; and the light-houſe built by an individual upon the Iſle of May, which returned to Miſs Scott a perpetual income of 1500l. per annum, likely to grow into a tenfold tax. See Rur. Econ. of Aberd. p. 138.

canal can in almoſt every caſe be made at a much ſmaller expence than a turnpike road, capable of tranſporting the ſame quantity of goods, and can be kept in repair at an infinitely ſmaller expence: of courſe the very moderate tolls that need to be levied at firſt, will afford a more undeniable ſecurity to the lender."

It is not eaſy to impreſs the common run of the people with the idea of creating neceſſaries, conveniencies, and even luxuries, by a little degree of contrivance; yet this is a poſition which is eaſily conceived by the analiſing eye. If the ſtate of roads and navigation had been left wholly to the bounties of nature, without the improvement of art, the citizens of London would never have enjoyed that ſolid and accommodating pavement, which muſt unavoidably have remained a dead ſubject matter in Scotland; nor would the latter have received the reciprocrated advantage which has remunerated a proſperous condition to a place ſo remote from the metropolis. If roads and canals had not arrived to their preſent ſtate of improvement, where would have been the ſtint of commerce and navigation, or the pleaſures of a Bond-ſtreet lounge? Yet theſe facilities

ties are in a mere ſtate of infancy, and afford abundant and wonderful reſources in their progreſs towards perfection. If ſuch a fanciful thing exiſts as the Philoſopher's ſtone, it ſeems only to be found by the civil engineer in the digging of canals, conſtructing of roads and water works, and extending the unlimited power of mechanics to the reduction of animal labour: there is ſcarce indeed an end which man can wiſh for, but what this moſt honourable ſcience can facilitate; even the duſt of the turnpike roads may be conquered for a very inſignificant expence, (very far ſhort of the charge of ſtupid watering carts); and from the great extent of ſpace which is hourly occupied by the buſineſs and pleaſures of the kingdom, the accumulation of revenue might be rendered very perceptible in its aggregate returns from the moſt populous highways. If an exemption from the choakings and blindings of duſt, ſtill more perceptible in its effect upon the fine four-footed animals which are daily driven in ſpeed, and very ſpeedily reduced by thirſt and perſpiration, was only farmed of government for the carriages and horſes employed in pleaſure, it would afford a very reſpectable reſource; while

while it would prove a wonderful ſaving to proprietors, and an intereſting acquiſition of public wealth and ſtrength.

Reſuming the ſubject of roads and canals, with great truth it is ſaid by Doctor Anderſon, that *there is a maximum in all caſes of the kind—a line to which you can juſt come, and no farther. Within that line is the ſphere of poſſible cultivation: beyond it every improvement muſt be for ever ſtopped. Now no one can ſay where that line may be placed for particular articles; of courſe no one can ſay, but he himſelf may be affected ſomehow or other in a way that he cannot juſt now perceive. Let people conſider what a mortifying thing it would be to have themſelves placed beyond that line, when, by a little forecaſt on their part, they might have been far within it. There are thouſands of bulky articles of ſmall value, which, if brought within reach of market, might prove of ineſtimable value; not ſo much by the abſolute money they bring, as by enabling the owners to bring lime, and other articles of great utility, as a return carriage which could not otherwiſe have been obtained.

* Rural Econ. of Aberd. p. 140.

To

To apply then the inferences of this very able economic obſerver to the vaſt intereſts of England and Wales, it is now, and always, the appointed time to look forwards. The ſlate of Weſtmoreland (where the rights of common for ſheep are ſaid to fetch a rent of a penny per acre), may be the means of fertilizing extenſive diſtricts if the means of transfer can be ſo facilitated as to carry that ſlate to market with profit. The woods belonging to every gentleman in the county, if the lake navigations ſhall be improved and canals ſhall be extended clear of needleſs tolls, may be rendered the means of improving their eſtates, and of planting ſucceſſive woods upon ſuitable waſtes. Clay or ſtones of certain deſcriptions may poſſibly anſwer the ſame purpoſe; and, perhaps, mines may be farther diſcovered in the ſearch which will be made for theſe. The ſand and manure of the ſea coaſts may be reciprocated in return, and by this means the cold and clayey ſoils may be ameliorated, after its bogs have been drained and rendered arable by the induſtry of national irrigation. In ſhort no one can ſay what a variety of articles may in future be diſcovered among thoſe bleak and heathy wilds of the Northern Counties,

which prejudice and inexperience have deemed as impracticable in our day as the wonderful effects of the ſteam engine would have been declared in the moſt lucid days of our anceſtors, or the diſcovery of a weſtern world before the enterprize of a Columbus.

Among the various obſtacles which impede the progreſs of ſucceſs in the operation of canals, and which diminiſh the profits which are expected from them, Doctor Anderſon, very juſtly I think, reprehends the rage for extravagantly magnificent things, greatly diſproportioned to the wants and to the preſent circumſtances of the country *.

"When a great deal of money," ſays he, "is expended on a canal, through which there cannot for many years be much commerce, the pontage dues are neceſſarily ſo high as to repreſs the trade upon it to an aſtoniſhing degree. Even at preſent the expence of pontage, on the canal from the Forth to Glaſgow, is ſo high, that nearly one half of the goods that go from Edinburgh to Glaſgow can be ſent cheaper by land. Had it been a ſmall canal, on which the pontage would not neceſſarily have

* Rural Econ. of Aberd. p. 140.

amounted

amounted to one fourth part of that per ton, the intercourſe upon it would have been a hundred times greater; and this extenſion of intercourſe would have enabled them to have lowered it ſtill much farther than that.

Better therefore to make a ſmall canal originally that ſhall be proportioned to the preſent wants of the country, and when the intercourſe becomes ſo great as to require a larger one to make the canal then larger, than to expend at the firſt a great deal of uſeleſs money, which, inſtead of benefiting, muſt tend to prove hurtful to commerce."

I think, however, we may now venture to prognoſticate, that if ſuch counties as Weſtmoreland, Cumberland, and a great part of Yorkſhire and Lancaſhire, ever enter upon a ſyſtem of ſmall canals, as they certainly are intereſted to do, they will never ſee the day when they would wiſh to enlarge them, howſoever paradoxical it may ſeem to them at preſent ſhould they be told that a ſmall canal ſyſtem will transfer more goods than a large one, although the expence of conſtruction may not perhaps exceed a third or fourth part of the former, averaging all ſituations and circumſtances.

* "The public have been precluded from receiving the benefit of canals in many caſes," adds the Doctor, "from the circumſtance of our having univerſally adopted the plan of lowering and elevating boats by means of water-locks alone, which, by requiring ſuch a vaſt ſupply of water, renders it impoſſible to have a canal at all in many caſes where they would have been otherwiſe practicable, and in all caſes greatly augments the expence that would be neceſſary if theſe could be diſpenſed with; beſides retarding the intercourſe by reaſon of the numerous ſtoppages they occaſion; for as no water-lock can conveniently be made to lower at once above ſix or eight feet, where a riſe is conſiderable, they muſt occaſion frequent ſtoppages; whereas, in the other way, it would make little difference to lower eighty feet or eight. But I muſt not now ſtop," he obſerves, "to detail the benefits that would in ſome caſes be derived from this circumſtance. Theſe would ſometimes approach to infinity.

"We have farther," he ſays, "been in a yet more eminent degree deprived of the

* Rural Econ. of Aberd. p. 141.

benefits

benefits of water carriage, in innumerable caſes, from the circumſtance of our never having attended to the benefits that might be derived from the conveying water canals on a level through a great extent of country, as may often be done at a very ſmall expence, along the ſides of low ranges of riſing grounds, for very great diſtances through corn countries, which would not only ſhorten the diſtance of land carriage of corn, &c. to market, even where the canal could not go the whole way, but alſo would, in innumerable caſes, facilitate the conveyance of lime and other manures from one part of the country to another.

* Were a method deviſed for conveying loaded boats from one canal into another, without the aid of water locks—and were canals made of a ſmall ſize, and conſequently at a cheap rate—and was the neceſſary attention beſtowed to carry every canal as far as it poſſibly could go upon the ſame level through the country in all directions, there is not a doubt but that goods could thus be conveyed at a ſmall expence by water car-

* See Political Economy of Inland Navigation, &c. p. 80, 91, 95, 101, 107, 110, 113.

riage to and from almoſt every corn farm in this extenſive diſtrict *.

"To obtain all theſe benefits," rejoins this ineſtimable friend of mankind, "I would propoſe that every canal ſhould be conſidered preciſely as a public road, and put under the management of the Commiſſioners of Supply in every diſtrict, exactly as the turnpike roads are at preſent. After proper ſurveys have been made, and the practicability of making a canal in any particular diſtrict aſcertained, an act of Parliament ſhould be obtained for making ſuch or ſuch a canal, and for levying tolls, to be ſpecified in the act; the whole proceeds of which ſhould be applied, in the firſt place, for the payment of the ſums expended on making the canal, with intereſt till paid up; and upholding the canal itſelf, and nothing elſe, and extending it farther, if judged neceſſary; and after this money was paid up, the tolls on that canal to be lowered, ſo as to amount to no more than is neceſſary for keeping it in thorough repair.

For the purpoſes of internal commerce, it does not ſeem neceſſary ever to have a boat

* Aberdeen.

wider,

wider, in any caſe, than four feet; nor the draught of water above two or three feet; for as the length of the boat may be indefinite, it is eaſy to proportion that to the burden intended: of courſe, where the circumſtances are ſuch, as that the boats will not be very frequently paſſing each other, a width of five feet, and a depth of two feet and a half, or three feet at moſt, are ſufficient. Where canals of this ſmall ſize are adopted, a niche may be made at the ſide at every quarter or half mile or ſo, ſufficient to receive one boat until another paſſes, where they chance to meet.

I am aware of the objection that will here occur, on account of the great reſiſtance that would be made to boats paſſing in a canal, with ſo little vacant ſpace on each ſide of the boat; but as every perſon, in the leaſt acquainted with the laws of hydroſtatics, knows that the reſiſtance from the water would be equally diminiſhed if there was one inch depth of water only on the ſurface, as if there were a thouſand fathoms deep, this objection may be entirely obviated by laying the earth that comes out of the canal five or ſix feet back from its edge, ſo as to allow the water there to flow over the origi-

nal ſurface of the ground. By this means, the breadth of canal wanted is obtained without any expence; ſo that to dig a deep canal under the pretext of widening it, for the purpoſe of removing the reſiſtence, is a mere uſeleſs expenditure of money.

"As it muſt happen, however, that by thus widening the canal, the evaporation will be thereby augmented; to guard againſt this inconvenience, it will be always adviſeable to make the towing path, if poſſible, on the North-eaſt ſide* of the canal, and to plant the oppoſite bank all along cloſe with willows, which by their ſhade will ſcreen the canal from the influence of the ſun, and by their ſhelter defend it from the drying effects of the South-weſt winds which ſo much prevail in this climate during the ſummer ſeaſon.

"Near the ſea, or any great town, where the intercourſe muſt be more frequent, the breadth of the canal may be nine or ten feet, ſo that two boats may paſs each other everywhere, having the ſame depth as before.

"A canal on this plan would in ſome meaſure reſemble a river. The principal

* The prevalency of winds vary in different places.

trunk

trunk ſhould be of the larger ſize; the leſſer branches, that went off to particular places, would be of the ſmaller. The expence of making a canal of this kind would be very ſmall, for little earth would require to be removed. Were a ditch, five feet wide and two feet deep, to be dug out of the ſolid to the whole depth, it could, on an average, be dug at the expence of* ſixpence a yard; but when it is conſidered, that by throwing the earth principally to the lower ſide, the water may be raiſed above the level of the ground, it will not require to be caſt ſo deep, and of courſe the expence of making it would be leſſened. This will be a large allowance for the ſmall canals; and one ſhilling per yard a full allowance for the larger, not including the expences of locks, aqueduct-bridges, &c. This is upon the ſuppoſition that they are to be carried upon the level†, following the form of the ground wherever it may lead to; but where hollows are to be croſſed, which ought never to be done but in caſes of ex-

* Prices are local: this is at Aberdeen in Scotland. W. T.

† This general rule will meet many exceptions. p. 22, one in Leach, p. 107. Liſkeard canal.

treme

treme neceſſity, an additional expence will there be incurred, as well as for aqueduct-bridges, where theſe become neceſſary. Theſe expenſive works can only become requiſite, however, on the larger branches; the ſmaller ramifications which fall into theſe can ſcarcely ever require the aid of ſuch expenſive erections.

As to bridges for allowing the water to paſs under the canal, unleſs where the ſtream is conſiderable, this will not be neceſſary; for by making the towing path always on the upper ſide of the ditch, and leaving at proper places a long level on the lower bank, at the ſame height it is ever meant to riſe to, whenever ſuperfluous water, from tranſient rain or other cauſes, came into it, this would flow over theſe long levels with a calm ſilence that would never be felt.

"Were a trunk canal of this ſort carried along the rivers of Aberdeenſhire," concludes the Doctor, "the Dee alone excepted, which is too rapid, and too much confined on each ſide by mountains, eaſily to admit of it, and were leſſer canals branched off from it at every rivulet that flowed to any diſtance through a level part of the country, its improvement would be wonderfully facilitated;

and

and when the ſmallneſs of the expence of ſuch erections is conſidered, and when it is alſo adverted to, that by this means the expence of highways would be conſiderably diminiſhed by removing from them all weighty carriages, this will not appear to be a difficult enterprize; for it will require much leſs money to make one of theſe canals than a turnpike road of the ſame length; and the keeping it in repair, when once made, would be, in compariſon of a road, next to nothing."

The Doctor next proceeds to exemplification of the principles which we have been tracing; but as an examination of theſe would require a detail knowledge of the country, I ſhall content myſelf with noticing a few ſtriking particulars which may be of general uſe. He points out the various levels and places proper for branches and ramifications diverging into every quarter of the country, and ſays that nothing could be better deviſed for giving a perfect idea of the plan which ought to be adopted for forming canals of the kind he alludes to, than the parallel roads in Glenroy, near Fort William.

* "Theſe

* "Theſe roads," he ſays, "are carried forward along the ſides of the hills, in a direction everywhere perfectly horizontal. Wherever they come to a cavity in the hill, they there bend inwards till they find the natural level; and where they come to a river, inſtead of ſinking down to the level of its bottom, or requiring to have a bridge directly acroſs it to raiſe the ground to its proper level, they turn up the bank of the river, keeping ſtill the horizontal direction, till they thus gradually reach the bottom of the ſtream; when croſſing it, and altering their direction once more, they *purſue* the courſe of the ſtream on the oppoſite bank till they reach the ſtrath, when they proceed forward in the ſame horizontal direction as before.

From this unaccountable work of a barbarous age, we may be taught one important leſſon in regard to the conducting of canals, which ſeems never yet to have been adverted to; viz. that in many caſes it may be practicable to carry forward a canal at leſs expence through a country intermixed

* Rural Econ. of Aberd. p. 146.

with

with long ridges of hills, than in thoſe that are low, and in general of a ſmooth ſurface; for even where the declivity of the rivers are conſiderable, if the hills are not diſcontinued, a canal upon the ſame level may be carried forward very far, and cannot be interrupted by the leſſer ſtreams that fall into the vale, becauſe the declivity of theſe rills is ſo great, that the canal requires to be carried but a very ſhort way out of its direct courſe, before it finds its level acroſs it, ſo as to avoid the neceſſity of having aqueduct bridges there; whereas, in more level countries, theſe rivers often flow through a long courſe of level ground, which cannot be croſſed without either locking down on each ſide of it, or turning out of the way a great many miles before you can croſs the river upon the original level. Many benefits, however, would be derived to the country, were the conductors of canals to be in general much more parſimonious of their locks than they uſually are, ſo as to endeavour to try, in every caſe of this kind, to croſs the interrupting vale and ſtream upon the natural level of the canal.

It would be improper to enter in this place into farther particulars on this head, or to enlarge

enlarge on the benefits the country would derive from the opening up of a communication of this ſort, which are indeed ſufficiently obvious. The difficulty will be to perſuade moſt men that a thing which is repreſented as ſo eaſy, can in fact be literally practicable; becauſe they think if it had been practicable it would have been long ago adopted. To this objection I ſhall make no anſwer; but beg leave only to ſtate the following fact.

After tolerable roads were made through moſt parts of Scotland, ſo as to admit of their having free intercourſe with other places, Archibald Duke of Argyle and other gentlemen of that country were deſirous to open a communication between the peninſula of Cantyre and the other parts of Argyleſhire, which was disjoined from them by a rugged ridge of very high hills between which no paſſage could be found. Many ſurveyors were ſent to explore this rugged region; but all of them returned with the moſt diſcouraging report. Moſt of them ſaid that it was not poſſible to make a paſſible road at any expence for about ſeven miles of that diſtrict. Others reported that it might perhaps be poſſible; but that at the loweſt

loweſt eſtimate which could be made the expence would exceed thirty thouſand pounds. This was a ſum ſo enormous that the idea of executing it was for the time abandoned. Still however the neceſſity of having ſuch a communication occurred, and it became an endleſs ſubject of converſation at the county meetings. At length one gentleman obſerved, it could never be done if they did nothing but talk about it; and propoſed that they ſhould try to do ſomething. It was immediately reſolved to open a voluntary ſubſcription to make at leaſt a beginning, and try what could be done. Fifteen hundred and odd pounds were ſubſcribed at the meeting, and a committee was appointed to ſee the money expended, and to make a report how far it went. The work was begun and carried on with alacrity while the money laſted; and, to the perfect aſtoniſhment of the next meeting, they laid their report before it, when it appeared that the whole of the road was completed in the moſt perfect manner, and better than one hundred pounds of the money remained at the diſpoſal of the meeting. If, before this trial was made, any perſon in the county had ſaid it might be effected for fourteen hundred

pounds, he would have been laughed at for advancing ſuch an abſurd opinion."

A ſimilar thing happened within my knowledge at Lumbeſton in North Carolina. Near this place, upon Drowning Creek, there is a branch of that creek called the ſaddle-tree ſwamp which is narrow and paſſable at its junction with the creek, but widens conſiderably and is difficult to paſs on account of the mire and thickets, till it extends ſome diſtance up into the neighbourhood. The path which croſſes the mouth of the ſwamp is ſo near the bank of the creek, that in the time of freſhes, or land floods, it is greatly inundated; and as people often encountered the riſk of croſſing this place in preference to going a round-about way, ſeveral perſons had been drowned. I obſerved, from the formation of the land, about a bow ſhot from this place, that notwithſtanding the impervious aſpect of the thicket, there appeared to be there a more ſolid foundation and no great diſtance through the ſwampy part; and I propoſed to fall upon ſome plan or other to open a new croſſing place; but this was deemed to be, if not wholly impracticable, at leaſt a very difficult undertaking. I at length propoſed that

that voluntary working parties of the neighbourhood ſhould encounter it, by way of a frolic, on Saturday afternoons, till we either ſucceeded or were tired of the experiment; and that *I* would furniſh rum. This laſt propoſition had ſufficient charms to ſet half a dozen axes at work; and we not only reduced the job under a day's work, but opened a cart-way through a better part of the woods for at leaſt half a mile beyond it.

I recite theſe caſes to ſhew how frequently that bugbear, ideal impoſſibility, deters men from undertakings of the higheſt importance to themſelves and country, when the only great difficulty is to ſet about the buſineſs with that true ſpirit and energy which is competent to remove every obſtacle that may be impeded.

Of the Ways and Means for conſtructing Works for National Irrigation.

I feel a delicacy in the taſk of digeſting a plan for carrying into execution the various works of national benefit which I have ſuggeſted; not, however, that I perceive any

great difficulty in the buſineſs, but it is enough that I am not officially employed.

Hints may, nevertheleſs, be of uſe to thoſe who are more immediately concerned; becauſe they may call to their recollection both variety of methods, and choice of ſubject matter to be acted on.

In the progreſs of this work, under the head of *Irrigation of the Northern Counties*, I have ſuggeſted ways and means of operation which I think government may uſe to very great advantage, whether it *is* viewed as a public or private undertaking. In the one caſe they will hold the agency and profit in their own hands, by means of their officers; and in the other, they may either reſerve a certain portion, or moiety perhaps, of the intereſt which ſhall annually ariſe, or they may ſell or farm out the privilege of national irrigation upon ſpeculation, on the faith of a parliamentary guarantee. This, I apprehend, without infringing private rights of property, may be legally granted for the conſiderations of accumulating revenue and national ſtrength.

Doctor Anderſon ſeems to object to any other mode of extending canals than that which has been adopted for the ſupport of

turnpikes. His motive is certainly a laudable one; and it ſhould heartily meet my approbation if it were practicable to carry his plan into execution: the queſtion ſeems to reſt chiefly in the ſpirit of the times, and will of men in power.

Private means are often adequate to very great undertakings; but there are many inſtances where ſucceſs muſt depend entirely on a combination of powers and circumſtances, or where the ſupreme intervention of the community becomes eſſential. In favour of national irrigation, the interruption which ſmall poſſeſſions might impede in the way of ſyſtem, and of improvements of the greateſt conſequence to all, is a ſtrong argument; for it will be always found, in practice, that one obſtinate man may do a great deal of miſchief, or prevent a great deal of good to his neighbours; and that if men are not previouſly bound, by their joint agreement, to take a fairly-aſſeſſed compenſation for unavoidable injury to individuals, (a method which I would always recommend in the extenſion of water works, roads, and canals), the generality are prompt to ſtand out for an extortionate remuneration which procraſtinates the buſineſs intended; and if it ſo hap-

pens that the law has been ſilent on this point, the undertaking muſt either ſubmit to a groſs impoſition or ſtand ſuſpended; although the refuſing party is aware that his eſtate muſt become eventually improved in value by the very completion which he withholds his conſent from.

Theſe are circumſtances, among others, which ſeem to indicate the propriety of undertaking works of national irrigation on the ſtrength of the public purſe, and returning the annual profits by a rent ſtipulated for the reſpective quantums of benefit, without intruding the odious term *taxation* upon the ear which feels ſorely galled.

In executing the work, I preſume, if undertaken for public account and riſk, there would be no impropriety in employing the ſoldiery who may have leiſure for ſuch labour. The Spaniſh ſoldiers avail themſelves of the king's extra pay for their labour in works of public utility, and this is deemed highly honourable. It fits them moreover for the duties of their profeſſion; and thus familiarizes them to many fatigues of a campaign, which are rendered lighter by habits of induſtry and the acquirement of profeſſional knowledge. In reſpect to the

ſoldiery who return on the eve of peace, it would be anticipating a means of ſubſiſtencè; and an occupation of more honour and profit than was ever drawn from the ſource of robbery: above all, it cannot be leſs honourable to work for the king than for his ſubjects, and I am perſuaded that patriotic attachments and zeal for the public intereſt would ſtimulate a ſoldier to much national ſaving.

The ordinary ways and means of conſtructing canals, are too generally underſtood to need my feeble explanation; I only lament that ſo little attention is paid to the expanſive capacity of finance, and that mankind are ſo exceedingly tenacious of the treaſure in the napkin. It might be greatly accumulated by good and faithful ſtewards of the Lord's intereſt! but it is not my province to criticiſe the non-feaſance of ſocial duties.

There ſeems to be one general point in which all the reſpectable writers on ways and means to increaſe the public revenue ſeem to agree—The public demands ſhould contemplate the leaſt poſſible inconvenience to the pockets of individuals; but, whereever it becomes neceſſary that theſe ſhould be touched, let the reciprocity be made as

viſible as poſſible; for it may be obſerved that right demands taxation, but prudence ſends conciliation in the company of right. Mr. Middleton and Doctor Anderſon prefer the turnpike ſyſtem: it carries fairneſs on the face of it, becauſe mankind ſee the benefits they are paying for. Others prefer mortgaging the premiſes for the means of execution, until the tolls ſhall redeem the expences and ſet the people free. Both, I apprehend, attain the ſame end in reſpect to the ultimate reſult: the one ſtrengthens the national reſources by its voluntary encouragements to a national induſtry which accumulates public wealth and ſtrength for a latteral reſponſibility; and the other demands remuneration for a viſible accommodation.

The only difficulty lies in the preſent ſtate of public neceſſity; Government wants money to enable her protection to ſociety, and the queſtion is, how the ſaddle will gall the leaſt. I have ſuggeſted the principles of foreign and domeſtic popular confidence which occurred to me in my preliminary obſervations; and if I were a rich man, reſiding even in Paris, or in any other foreign land, I ſhould have no heſitation in ſpeculating

lating upon ſo ſafe a ſubject. We are not, however, without numerous precedents for the model of government loans upon the credit of their future proſpects; and, if I were ſo fortunate as to be a money-lender, I would certainly ſolicit this ſecurity in preference to any beyond the channel. I ſhall only offer one reſource more, which attaches to the condition of human depravity.

Hints towards employing the vagrant and diſorderly Claſſes of the Community in Works of National Irrigation, Inland Navigation, and Drainage; as a remuneration to Society for the Depredations they may have committed.

I ſuggeſt the following ideas, with hopes that they may call the attention of authority to the uſe which they may be of in the police of the metropolis more particularly, in regard to a compulſive application of the time of vagrants and petit criminals to a new ſpecies of induſtry in the item of irrigation; while means may be thereby obtained for the voluntary employment of the induſtrious poor in co-operative occupations.

I apprehend no man can have paſſed the ſtreets of London without being more or leſs incommoded by impertinent importunities from ſome deſcription or other of that diſorderly multitude denominated beggars; and I am perſuaded it would require nice judgment to penetrate the various deceptions that aſſimilate the impoſtor to the real object of charity, if the benevolent founders of numerous public inſtitutions had not ſo greatly removed the propriety of giving alms to ſo promiſcuous a deſcription of people.

Let us inquire then for a moment, whether that benevolent ſpirit of the Engliſh nation, which has been the boaſt of ages paſt, has produced a good or evil in this reſpect? Or, whether by the lure of miſtaken gratuities to innate ſloth, we do not bring about the very ends we incline to prevent; and, whether we do not thus induce many profeſſional impoſitions which it ſhould be our ſtudy to avert by providing means of ſubſiſtence for the worthy indigent, and compulſion for the uſeleſs or villainous.

That we may be better enabled to keep in view ſuch perſons as this kind of inquiry ſhould contemplate, we cannot refer to a better guide than that which has influenced

legiſlative

legiſlative deciſions through ſucceſſive ages, and afforded ſcope for the notice of that learned judge, Sir William Blackſtone, in his excellent Commentaries, under the head of *Offences againſt Public Economy*, vol. iv. p. 165, to 169.

Such a hiſtory of the riſe and progreſs of nuiſances and petty crimes againſt public economy, as that which the judge has been at the pains to trace from early dates, will not only be found ſomewhat inſtructive to many who are little in the habit of legal inquiries, but it may afford a ſcope of reflection to the curious mind, which will amply repay the trouble of referring to the ſubject; and it will in ſome meaſure prepare us for a more ready diſtinction of the ſeveral objects which the claſſification of misfeaſance ſeems to have fitted for the preſent occaſion.

When we paſs from the ſeveral periods which this very able judge has enumerated in ſumming up the reſpective legiſlative amendments which have been ſucceſſively interpoſed in this behalf, we might naturally have expected to find the condition of man very much ameliorated by this time, through the far-reſounding benefits of civilization! Whether this is, or is not the fact, advocates for

for the more refined ſciences will pleaſe to determine, while I content myſelf with a more humble ſphere, in contriving ways and means to reduce ſuch accumulated evils as a late reſpectable author has exhibited, by rough though ſubſtantial mechanical powers; for theſe would ſeem beſt calculated to bring the worthleſs part of Society to a ſenſe of its duties to the aggregate whole, and, to eradicate the inconveniencies now inquired into with their many-coloured variety of concomitant miſchiefs.

The author to whom I here allude, Mr. Colquhoun, in his ineſtimable treatiſe concerning the police of the metropolis of England, (1796–1797), while enumerating the various crimes and miſdemeanors with which London is infeſted, eſtimates 170,000,000 pounds worth of property to be ſubject to daily depredations; and, after an herculean labour in collecting facts for which his judgment and aſſiduity ſeem to have been peculiarly adapted, he enumerates the detail of this cohort of very formidable depredators in the following eſtimated ſchedule.

Eſtimate

* *Eſtimate of Perſons who are ſuppoſed to ſupport themſelves in and near the Metropolis, by Purſuits either criminal, illegal, or immoral.*

Profeſſed thieves, burglars, highway robbers, pickpockets, and river pirates, who are completely corrupted; many of whom have finiſhed their education in the hulks, and ſome at Botany Bay	
N. B. There will be a conſiderable increaſe of this claſs on the return of peace, now eſtimated at about —— ——	2,000
Profeſſed and known receivers of ſtolen goods, of whom eight or ten are opulent — —	60
Coiners, colourers, dealers, venders, buyers, and utterers of baſe money, including counterfeit, foreign, and Eaſt-India coin —	3,000

* Treatiſe on the Police, Introductory Addreſs, p. vii.

Thieves,

Thieves, pilferers, and embezzlers, who live partly by depredation, and partly by their own occaſional labour — — 8,000

River pilferers, viz. fraudulent lumpers, ſcuffle-hunters, mudlarks, lightermen, riggers, artificers, and labourers in the docks and arſenals 2,500

Itinerant jews, wandering from ſtreet to ſtreet, holding out temptations to pilfer and ſteal, and jew boys crying *bad ſhillings*, who purchaſe articles ſtolen by ſervants, ſtable boys, &c. &c. generally paying in baſe money — 2,000

Receivers of ſtolen goods from petty pilferers at old iron ſhops, ſtore ſhops, rag and thrumb ſhops, and ſhops for ſecond-hand apparel, including ſome fraudulent hoſtlers, ſmall butchers, and pawnbrokers 4,000

A claſs of ſuſpicious characters, who live partly by pilfering and paſſing baſe money; oſtenſibly coſtard-mongers, aſs-drivers, duſtmen, chimney-ſweepers, rabbit-ſellers, fiſh and fruit-ſellers, flaſh coachmen, bear-baiters, dog-keepers (but in fact dog-ſtealers) &c.&c. 1,000

Perſons in character of menial ſervants, journeymen, warehouſe-porters, and under clerks, who are entruſted with property, and defraud their employers in a little way, under circumſtances where they generally elude detection, eſtimated at about — — 3,500

A claſs of ſwindlers, cheats, and low gamblers, compoſed of idle and diſſolute characters, who have abandoned every honeſt purſuit, and who live chiefly by fraudulent tranſactions in the lottery; as morocco men, ruffians, bludgeon men clerks and aſſiſtants during the ſeaſon, who at other times aſſume the trade of duffers, hawkers and pedlars, horſe-dealers, gamblers with E O tables at fairs, utterers of baſe money, horſe-ſtealers, &c. &c. — — — 7,440

Various other claſſes of cheats, not included in the above, (but deſcribed in pages 148 to 158, vide pages 148, 421, Tr. Pol.) 1,000

Fraudulent and diſſolute publicans who are connected with criminal

minal people, and who, to accommodate their companions in iniquity, allow their houſes to be rendezvous for thieves, ſwindlers, and dealers in baſe money – 1,000

A claſs of inferior officers belonging to the cuſtoms and exciſe, including what are called ſupernumeraries and glutmen; many of whom connive at pillage, as well as frauds committed on the revenue, and ſhare in the plunder to a very conſiderable extent: principally from their inability to ſupport themſelves on the pittance allowed them in the name of ſalary: eſtimated at – – – 1,000

A numerous claſs of perſons who keep chandler ſhops for ſale of proviſion, tea, and other neceſſaries to the poor: the total number is eſtimated at ten thouſand in the metropolis; a certain proportion of whom, as well as ſmall butchers and others, are known to cheat their cuſtomers, eſpecially thoſe to whom they give a little credit by falſe weights, for which (except-

ing

ing in the pariſh of Mary-le-bone) there is no proper check. – 3,500

Servants, male and female, porters, hoſtlers, ſtable boys, and poſt-boys, &c. out of place, principally from ill behaviour and loſs of character, whoſe means of living muſt excite ſuſpicion at all times, about – – – 10,000

Perſons called black legs, and others proſelyted to the paſſion of gaming, or purſuing it as a trade, who are in the conſtant habit of frequenting houſes opened for the expreſs purpoſe of play, of which there are at leaſt forty in Weſtminſter, where pharo banks are kept; or where hazard, rouge et noir, &c. are introduced. Of theſe, five are kept in the houſes of ladies of faſhion, who are ſaid to receive 50l. for each rout, beſides one eighth of the profits; ſeven are ſubſcription houſes; five have cuſtomers particularly attached to them; and thirteen admit foreigners and every idle and diſſolute characters, who

are either introduced or known to belong to the fraternity of gamblers; where a ſupper and wines are always provided by the proprietors of the houſe for the entertainment of their cuſtomers — 2,000

Spendthrifts, rakes, giddy young men, inexperienced, and in the purſuit of criminal pleaſures, profligate, looſe, diſſolute characters, vitiated themſelves, and in the daily practice of ſeducing others to intemperance, lewdneſs, debauchery, gambling, and exceſs; eſtimated at — — — — 3,000

Foreigners who live chiefly by gambling — — — 500

Bawds who keep houſes of ill fame, brothels, lodging houſes for proſtitutes, &c. — — — 2,000

Unfortunate females of all deſcriptions, who ſupport themſelves chiefly or wholly by proſtitution 50,000

Strangers out of work, who have wandered up to London in ſearch of employment, and without recommendation, generally in conſequence

ſequence of ſome miſdemeanour committed in the country; at all times above - - -	1,000
Strolling minſtrels, ballad ſingers, ſhowmen, trumpeters, and gypſies - - -. -	1,500
Grubbers, gin-drinking diſſolute women, and deſtitute boys and girls, wandering and prowling about in the ſtreets and bye places after chips, nails, old metals, broken glaſs, paper, twine, &c. &c. who are conſtantly on the watch to pilfer when an opportunity offers - - -	2,000
Common beggars and vagrants aſking alms, ſuppoſing one to every two ſtreets - - -	3,000
Total	115,000

Whether, in reviewing this horrid catalogue of offences and miſdemeanours, we ſhould attribute their increaſe to antient ſeverities not yet expunged from the law, which men are loth to execute on their fellow creatures, (though indeed we now find

many ſpecies of crimes that were unknown to former ages, and appear, in a great degree, to owe their accumulation to the rapid progreſs of opulence and the arts) it is not for my preſent purpoſe or convenience to inquire into. It would, in any event, ſeem rational to conclude, in relation to villainy, that that is the beſt mode of puniſhment that can be adapted to the nature of ſocial compact, which contributes to remedy its defects, and to attain its wiſeſt ends at the leaſt poſſible expence, with the leaſt (but effective) degree of cruelty, in a way to compel ſome degree of reſtitution from him who has injured the community by malfeaſance; and ſo that the aggreſſing individual may rather be reſtored to ſome uſeful function in ſocial intercourſe when he is corrected, than to be rendered an outcaſt under a ſtigmatized and irrevocable doom; or be cut off, perhaps, in the prime of life, under that ſocial right of inanimating which the law aſſumes; but which I confeſs myſelf unwilling to aſſent to, on the mere precedent of earlier days, if it were poſſible to diſcover a more lenient ſubſtitute.

I ſhall therefore barely ſuggeſt a workhouſe amendment to the conſideration of thoſe

thoſe in power, by means of an incloſed wheel of about thirty feet diameter, for calculation ſake, leaving the actual conſtruction, in point of ſize and application, to the opinions of thoſe who may happen to be more nearly concerned; for ſuch a kind of walking wheel requires merely the leverage of corporeal gravity put in a ſtate of motion to employ it; and therefore places all men upon a footing of fair equality in gaining a ſubſiſtence proportioned to their bulk and appetite; being perfectly independent of tuition, myſtery, art, trade, or any particular profeſſion or habit.

With reſpect to the mode of erecting one of theſe wheels, I would recommend that it be incloſed in a room ſo nearly approaching to its own width, that, when the doors of the wheel were open, a complete paſſage ſhould be formed through it from one room to the other, on each ſide of the wheel room. By this means, no other road being left open, the labourers ſhould be made to paſs through a proportionate work of the wheel in going to their meals and to their bed rooms. Their diet ſhould be wholeſome, and plentifully laid in; and always ſerved on a plain decent

table in the room oppoſite to that from whence they were to depart. Compulſive meaſures, other than the cravings of natural appetite, would be thus ſpared, or greatly diminiſhed at leaſt. The doors of comunication through the wheel ſhould be ſhut with ſpring bolts and pullies for the management of them, ſo that the ſuperintendants or directors might manage them *without* riſque.

In a ſimilar way, I think, the more honourable contrivance of open wheels might be conſtructed in various places, in order to aid poor induſtrious perſons out of employment with a certain means of ſubſiſtence. In theſe, inſolvent debtors, priſoners of war, and other children of diſtreſs, might obtain a little help towards a comfortable ſubſiſtence, as ſome little alleviation of their reſpective miſeries.

For example, then, if we calculate the application of animal gravity, in this way, to mechanic powers for pumping water by a common forcing pump, to ſupply a reſervoir elevated ninety feet above the ordinary ſurface, for feeding the ducts or water pipes of a town ſupplying canals, &c. we may ſay as follows: let the dimenſions of the great wheel

wheel propoſed be called thirty feet diameter. We will make choice of a pump of four inches bore, having its piſton worked by a crank of nine inches ſweep, admitting a ſtroke of eighteen inches to every movement of the piſton, which is once up and down for every revolution of the crank axis.

Deſigning to calculate in round numbers, always throwing away fractions againſt our allowance of power, that we may be ſtill more certain than otherwiſe againſt caſual reſiſtance, we are to conſider that a column of water equal to eighteen inches ſtroke and four inches diameter, contains two hundred and twenty-ſix cubic inches, and eighteen fractional parts.

A column of water of this ſize, raiſed to the height of ninety feet above the ſurface, contains 12063 cubic inches, and weighs 7865 ounces avoirdupoize weight, or 491lb. $9\frac{1}{10}$oz.

If we were to ſuppoſe each man walking in the wheel to average 150lb. avoirdupoize, and allow him the full advantage of fifteen feet leverage, (that being half the diameter of the propoſed wheel, and ſo far from the centre of gravity), he would produce a power at the end of the horizontal lever of 1680lb.

after deducting an allowance of $\frac{1}{5}$ for reſiſtance. But as by this mode of applying levers, &c. to rotary motion, a man walking in ſuch a wheel cannot be ſuppoſed to make good his weight above the medium angle of forty-five degrees, we muſt be contented to allow him the leverage of a horizontal beam as far as the interſection of a perpendicular line drawn from the point marked by the given angle, on the circle, would interſect on the horizontal beam, which is near and about eleven feet leverage, producing a nett power of 1320lb.

I will now allow each man employed to work two of theſe pumps of four inches bore. At this rate the reſiſtance in the two columns of water, each 90 feet high, will be 938lb. with ſome little friction on the works beſides; and the power to be applied or oppoſed to this reſiſtance will be 1320lb. which leaves 327lb. ſpare power to overcome the reſiſtance with, and may, I preſume, be conſidered very light labour.

Now the piſtons being moved up and down in the pump, by means of the crank, as it is turned round by the trundle or ſpur-wheel, raiſes and depreſſes the two pump-rods, and there are two ſucceſſive ſtrokes of

eighteen

eighteen inches each made by theſe two piſtons for each revolution of the crank, ſpur, or trundle-wheel. And if the wheel which works in the ſpur or trundle has three times as many coggs as the ſpur or trundle has ſpurs, ſtaves, or rounds, the ſpur or trundle and crank will make three revolutions for each time which the great wheel moves round; and as each crank, reſpectively employed, will perform its ſtroke, there will be ſix ſtrokes diſcharging each a column of water eighteen inches high, and four inches diameter; containing each 226 cubic inches for each and every revolution which is performed by the great walking wheel.

Every poſſible care ſhould be taken to avoid friction, by conſtructing the machinery ſo as to move the piſton-rods perpendicularly. Various methods have long been tried for improving this purpoſe; ſuch, for inſtance, as vibrating-levers, jointed crank-rods, friction-rollers of ſeveral kinds, &c. But I think none approach ſo near rectilineal perfection as the new method uſed by Mr. Foulds, at the London Bridge water works, and that by Mr. Cartwright, applied in the patented ſteam engine *.

* See Philoſophical Magazine for July 1798, p. 1.

The circumference of the great walking wheel is 90 feet, or 30 yards; and the yards in a mile are 1760: which ſum, divided by 30, gives $58\frac{2}{3}$ turns in a mile.

If then we regulate the velocity of the great wheel to only two miles an hour, (which cannot, I think, be conſidered as very hard walking, after lazineſs ſhall have acquired the habit through inducement or coercion), there will be $117\frac{1}{3}$ turns of the great wheel in an hour which wants but $2\frac{2}{3}$ turns of 120, and is near enough to be conſidered accurate at two turns in a minute, or one revolution of the great wheel for every half minute of time.

Hence we find that ſix ſtrokes are performed in each half minute of time by a wheel conſtructed for one perſon; making 720 ſtrokes per hour. This, when fractions are thrown away againſt caſual waſtage, being multiplied by the round number 226, which are the quantity of cubic inches forced into the main-pipe and diſcharged by each ſtroke of the piſton, produces 162,720 cubic inches per hour; which ſum being divided by 231, (which are the cubic inches contained in a gallon, wine meaſure), raiſes $704\frac{1}{2}$ gallons per hour. This ſum, divided

again

again by 63, gives above 11 hogſheads of water per hour for each man's weight, beſides 11 gallons and ſome fractions over; which, though nothing in compariſon with Meſſrs. Dixie and Mapleſtone's machine, is ſufficient for our purpoſe in the preſent computation.

If thus we only appropriate 9 hours in the day to labour, (which is but a walk of 18 miles per day: probably far leſs than that to which vagrant habits are accuſtomed), it ſupplies (with the aid of a few fractions), 100 hogſheads per man; and this product multiplied by 6, which is the number of perſons which, for farther eſtimates ſake, I ſuppoſe a wheel to contain at a medium rate, it would give 600 hogſheads per day; which may reaſonably enough be conſidered as a ſufficient ſupply for an equal number of moderate ſized families, obtained by the labour of ſix otherwiſe uſeleſs (perhaps criminal) beings, who have been heretofore wont to prey upon the induſtrious part of the community.

But if we either ſuppoſe the perſons who occupy ſuch a wheel to be men ſo far above the middle ſize as to weigh 200 lb. which is, I ſuppoſe, about the average weight of your

your firſt rate beef-eaters; or, if you make up an equivalent to ſuch a weight by the addition of ſupernumerary ſmall men, your power will then be 1788 lb. leverage per man, equal to the full leverage of the ſemi-diameter in the former caſe, and may be ſuppoſed to work one third more pumps with eaſe; which will be at the rate of 900 hogſheads per day, to a reſervoir elevated 90 feet above the ſurface of your *lower level.*

Eſtimating all conditions of perſons, then it certainly will not be deemed a ſeverity if we ſay, that when any man having the *uſe* of his legs can ſupply 100, and ſome men 150 houſes per day with water, through *the* mere application of their reſpective weights as a mechanical power, when applied to machinery; and this means of getting bread is once provided for them, (making a proper diſtinction between thoſe who work voluntarily, and thoſe who are under the * conſtraint of the law), there can be no need to encourage

* It will be obſerved, that when ſix men are thus incloſed in a wheel, there will be no occaſion for corporeal puniſhments; for the equilibrium being deſtroyed by the movement of one man's foot inſide, or by the overſeer's hand outſide, the obſtinate will have their choice

encourage begging in the ſtreets by a miſtaken charity, which has, I apprehend, a more frequent tendency to incommode the heart of indigent ſenſibility than to ſuccour real diſtreſs.

We have ſeen in Mr. Colquhoun's eſtimate of indolence and villainy, that the perſons in and about London alone who are ſuppoſed to ſupport themſelves by purſuits either criminal, illegal, or immoral, amount to no leſs a number than one hundred and fifteen thouſand!!!

Is it not then worthy of conſideration, whether the great and opulent City of London may not legally and conſtitutionally find thoſe who have ſo long wantoned with her inadvertency ſome conſtant employment of this nature, whereby the condition of the community may be bettered; thieves and vagabonds may be compelled to make ſome degree of recompence for their depredations on ſociety; and ſloth may be awakened to the habit of providing food and raiment

choice to move forward or fall upon their noſes; and the cravings of the ſtomach will be an inducement to "keep moving," when a breakfaſt or dinner is a thing certain at the end of a given diſtance.

through

through a more equitable medium than that of taxing the induſtry of others.

The ſyſtem of national irrigation which I propoſe, or, in other words, the ſcience of inland navigation, watering, and drainage, affords an abundant field for ſuch improvement; nor do I ſuppoſe there is a city in the univerſe, of comparative commerce and locomotion, where a defective attention to theſe moſt productive of all reſources and moſt intereſting of all facilities is ſo truly conſpicuous to the eyes of thoſe who are accuſtomed to think on theſe important ſubjects, and who calculate the means of accumulating public wealth, and of alleviating the miſerable condition of animal labour.

If we eſtimate upon the large ſcale for ſupplying the water of a canal elevated 90 feet above the ordinary ſources of the ſtreams, thus enabling ourſelves to extend ſmall branch canals into every part of the country, in a way to prove them aſſiſtants rather than oppoſers of the canals which are already conſtructed, we ſhall find that the moderate labour of theſe 115,000 middle ſized perſons (if it could either be compelled or induced), would feed no leſs than 341 miles of ſmall canals per day; or the greater quantity

tity of 511 miles if large men were employed: for, if we ſuppoſe three feet deep throughout, and a proportionate width to be ſufficient for this kind of conveyance, calculated to extend into and fertilize the remoteſt corners of the iſland, there will be about three cubic yards of water required for each lineal yard of canal; which is five thouſand two hundred and eighty yards to each mile. And if 115,000 idlers, of the ſmaller weight, are ſuppoſed to work two pumps to each man they will ſupply 1,804,882 cubic yards, or 341 miles, in nine hours. But if the greater ſized men are employed in the ſame wheel, they will be able to work three pumps to each man; and conſequently add fifty per cent. which is 511 miles of ſmall canal water per day: a ſupply, which after once being full, would probably reinſtate the abſorption and exhalation of the largeſt canal in the kingdom, to the whole extent of that diſtance.

Much more than this might be performed with the rotary pumps of Medhurſt, Dixie, and Mapleſtone, &c. in their preſent improved ſtate, of which I may in future have occaſion to ſay more; and there are many other methods far preferable to my example.

The

The ſpecimens I have given in the caſe of water to be raiſed by the common pump, may ſufficiently demonſtrate the capacity of this ſpare power of the nation for many other works in various parts of the kingdom. But it reſts with the wiſdom of the Legiſlature to draw ſuch inferences from this ſketch, as they may think intereſting to their conſtituents.

A Plan for raiſing the Supply of Water, which is delivered from the Mains to the ſeveral Houſes in Bedford Square for their Uſe in houſehold and culinary Purpoſes, up to the Roofs of the ſaid Houſes; for retaining the ſaid Water in Ciſterns, formed in the reſpective Roofs, ſo as to be ready at Hand in caſe of Fire; and for delivering fifty Gallons thereof per Day per Houſe, in a pure tranſparent State, obtained by the Uſe of a filtrating Medium, reſembling that by which Nature Acts in the cleareſt Emiſſion of her Springs.

It is preſumed that it will be needleſs to introduce this ſubject by an elaborate notice of

of the great advantages which ariſe from an eaſy command of water for culinary and houſehold occaſions; nor will it be neceſſary, in this place, to eſtimate the cheapeſt means. It will be ſufficient if it is demonſtrated by an approximate eſtimate, grounded on the actual prices which may be now engaged in contract, that it is a matter of comparatively cheap purchaſe to attain a command of water ready to extinguiſh fire, to waſh and ſcour the houſe without the labour of carriage up ſtairs, to promote an univerſal cleanlineſs, and to ſecure health and comfort in a greater degree than can be expected from the ordinary uſe of water charged with impurities and animalcula, and producing the dire effects of gravel and ſtone on the human conſtitution.

Bedford Square is underſtood to contain fifty-two houſes, whoſe fronts occupy an average of thirty feet each, depths an average of fifty feet each, and heights about ſeventy-five feet.

There are five ſtreets that enter this ſquare, *viz.*

1. Gower-ſtreet.

2. A new ſtreet leading to the Duke of Bedford's grounds.

3. Charlotte-ſtreet.
4. Caroline-ſtreet.
5. Bedford-ſtreet.

If we allow theſe ſtreets to occupy an average of 70 feet each, they will extend in all 350 feet on the ſide lines of the ſquare; and if we add to this ſum 52 houſes of 30 feet each, reaching 1560 feet more along the ſide lines of the ſquare, it will make the whole circumference of the ſquare amount to 1910 feet, or $477\frac{1}{2}$ feet diameter, or per ſide.

Now having ſtated theſe dimenſions, it follows to premiſe that two methods are preſented, whereby with the help of machinery, to be moved by wind, by ſteam, or by animal power, it is poſſible to diſtribute water from an ornamental building erected in the centre of the ſquare, into the tops or roofs of every houſe at a very moderate expence; more eſpecially when the combination of power and ſyſtem are applied to the operation.

Theſe methods are:

1. By means of an elevated tower, and chain, or forcing pumps.

2. By means of a receiver and diſtributor, aſſiſted by an air veſſel.

The

The firſt of theſe might be conſtructed in the form of a naval column ſimilar to the monument near London Bridge, a tower, an obeliſk, or a pagoda, whoſe height muſt be at leaſt equal to that of the houſes in the ſquare; and the building required for the moving powers might either form a part of the pile or be ſunk below the level line of the graſs plat, ſo as to impede no obſtacle in the proſpect.

The ſecond method (being independent of height), might be confined within the ſpace and form of a proportionate ſized temple of pleaſure; and it would be eaſy to mold the air-veſſel of the diſtributor in the ſhape of a handſome and uſeful ſtatue, far better than a ſtatue merely ornamental. In this caſe the horſes required to fill the main pipes, would work wholly out of ſight in a building beneath the level of the ſurface, and encircled by an iron rail, adding beauty to the temple within it, which might be accommodated with ſeats.

I will endeavour to make an approximate computation of the expence according to each of the ſeveral methods; but previouſly it is to be obſerved, that by the firſt propoſed method, the eaſy labour of two horſes

and a boy for one quarter of an hour each and every morning will be found fully competent to ſupply each houſe with one hundred gallons of water, elevated into its ſummit reſervoir; from whence the diſtribution is both ſimple and at option, according to fancy and the diſtributive arrangement of the pipes which communicate to the ſeveral apartments below the reſervoirs.

Agreable to the method which embraces the ſimple fountain principle, the water muſt be firſt elevated into the reſervoir of the tower or pagoda, and from thence, by means of communicating pipes, it may be made to find its own level on the top of any and every houſe in the ſquare; and it may be communicated along the roofs of the houſes to the ſummit ciſterns of each reſpectively, either in an open channel, or in a cloſe leaden pipe with proper air-tubes, &c. In this point, indeed, the ciſterns may be ſo conſtructed as to be capable of diſcharging their whole contents of water ſuddenly into the flames of any houſe which might happen to take fire.

There can be no invariable rule adopted for calculating the coſt of the pipes below; becauſe this muſt depend on the pleaſure of the

the party, in regard to the diſtributive arrangements which are preferred in the economy of the ſeveral families. And the leſſening of expence will partly depend alſo on the ſpirit of unanimity and accommodation which prevails throughout the neighbourhood; for if any one or more of the proprietors chooſe to decline their quota of the expence in the general work, it can be no reaſon for any inhoſpitable objections to permitting the pipe to paſs over the roof of ſuch houſe to the accommodation of the next neighbour.

The expence of the central building, in this caſe, is entirely a contingent matter, and depends wholly on the will of the parties concerned, and the degree of ornament they are inclined to beſtow on the ſquare.

The works which come under the more particular notice of a civil engineer are matters of regular calculation, which depend on the nature of the premiſes, the degree of elevation, and the quantity of water to be raiſed in a given time. If we allow each family to conſume one hundred gallons of water per day, on an average, the quantity demanded will be 5,200 gallons per day; the elevation 75 feet; and the length of

main pipe will be equal to five ſemi-diameters of the ſquare, or about 350 yards, if we deduct the width of the areas which ſerve as front yards to the houſes. One-fifth of this pipe being deſigned to let the water into the lower level, baſin, or reſervoir in the centre of the ſquare, from the main pipes of the public water-works, ſhould be equal in diameter to thoſe pipes which I ſuppoſe to be four inches.

If we allow the column of water, which will be thus contained in the aſcending pipe, to have an elevation of 80 feet, (for we ſhould add a few feet for ſafety's ſake) its weight will be about 436lb. avoirdupoiſe; which, together with the friction of the water acting on the pipe and the moving machinery, is the reſiſtance to be overcome by the two horſes, whoſe ſtrength is to be applied to the beam or lever.

On Dixie and Mapleſtone's machine, the reſiſtance againſt the riſing water will be little more than that of the common atmoſphere preſſing againſt the buckets; for theſe, being fixed on an endleſs ſtrap of chain or ropes, which paſſes in conſtant rotatory motion, will always balance each other.

If

If we allow the lever, to which the horſes are fixed, to make good a diameter of 26 feet 8 inches, from centre to centre of the horſe path, the circumference of the leverage will be 80 feet; which is exactly the pitch of the aſcending main or elevation which we have adopted: and, if the buckets moved only at the ſlower rate at which the horſes walk (which buckets I will ſuppoſe to be of equal contents to the four-inch main pipe before ſtated) there would be 436lb. avoirdupoiſe weight of water or thereabouts, which, at 8lb. per gallon, is $54\frac{1}{2}$ gallons, diſcharged into the upper ciſtern for each time which the horſes walk round the circle; making a diſcharge of 3564 gallons of water for one mile walking of the horſes: this, at the rate of two miles per morning, would do more than ſupply each houſe with 100 gallons, and allow amply for waſtage.

But as this would be a method of raiſing water by a very tedious proceſs, compared with what is practicable, let us ſuppoſe the drum, pin, or ſprocket wheel, round which the endleſs ſtrap revolves, to be 2 feet 8 inches diameter, and it will require 10 revolutions of this wheel to one revolution of

the endleſs ſtrap which is loaded with buckets. And, if the cog wheel, which is fixed on the perpendicular ſhaft into which the lever or beam is framed, has four times the number of cogs which the drum or ſprocket wheel has ſpurs or rounds, the ſame two horſes and boy will be fully competent to ſupplying all the houſes in Bedford Square with 100 gallons per day each by *light work* for one quarter of an hour each day; which labour might be performed, in routine, by the carriage horſes, as a morning's exerciſe; and would reduce the expence of boy and horſes to a total ſaving of this item.

The coſt in this way would be approximate to the following

Eſtimate:

Elm pipes.	£.	s.	d.
350 yards of elm main pipe, 4 inches diameter, at 2s. 6d.	43	15	0
Laying down ditto 350, at 6d. per yard – –	8	15	0
Joints, &c, at 1 foot per joint, 10 yards, at 2s. 6d. –	1	5	0
Cartage, 350 yards, at 2d.	2	18	4
Carried forward	£.56	13	4

Leaden

	£.	s.	d.
Brought forward	£.56	13	4
Leaden pipes.			
320 feet 2-inch aſcending pipe, at 7s. per yard - - -	37	16	8
1000 feet 1-inch diſtributing ditto, at 3s. per yard -	50	0	0
5500 feet half-inch deſcending ditto, at 2s. per yard	183	6	8
Soldering joints, ſay 10 per houſe, 520, at 2s. -	52	0	0
Balls and cocks, ſay each houſe 5l. - - -	260	0	0
52 ſummit ciſterns, each 6 feet every ſide, being 180 ſquare feet each, in all 9360 feet, at 7lb. per foot, is 585 cwt. at 1l. 10s. per cwt. incluſive - -	877	10	0
1 Reſervoir, 180 ſquare feet, at 7lb. per foot, 11 cwt. 1 qr. at 30s. - -	16	17	6
320 feet 2-inch deſcending pipe, at 7s. per yard -	37	16	8
Carried forward	£.1572	0	10

Brought forward	£.1572	0	10

Millwright's work.

Horſe mill for 2 horſes complete, 30 feet in diameter, at 4l. per foot per cuſtom	120	0	0

Dixie and Mapleſtone's machine.

Buckets and chain complete, 80 feet perpend. at 10s.	40	0	0
Extra work and fixing -	10	0	0
	1742	0	10
Allow for wooden work, tower, &c. - -	257	19	2
	£.2000	0	0
Drawings, labour, and contingencies, 20 per cent.	400	0	0
Four filtering machines, each 25l. - - -	100	0	0
	£.2500	0	0
Engineer and ſuperintendants, 5 per cent. - -	250	0	0
Total	£.2750	0	0

It will be here obſerved, that I have allowed a large eſtimate, and have perhaps computed a total expence greatly beyond that which would be ſufficient; and for which a regular artiſt or practical engineer would engage to perform the work. I am aware of this circumſtance, and have only to reply to it, that it ſeems to be often found that engineers engage for a ſum, in theory, which is found very inadequate in practice; and it ſeems therefore better to allow roundly at firſt, and let the proprietor, if he is diſappointed at all, be at leaſt very agreeably diſappointed.

In addition to the advantages which are promiſed, by this ſyſtem, to houſehold and culinary accommodation, there are many inſtances in which ſuch a command of water as is here contemplated may be applied to our gratification in luxurious indulgencies: baths may be thus eaſily and cheaply conſtructed in the cloſets of our bedchambers, and health, ſtrength, and cleanlineſs be thereby greatly promoted. Fiſh ponds may be thus contrived for the accommodation of private families, while the conſtant dripping of water may be made to cool and purify the air by means of evaporation, and a gentle breeze

breeze may be created in the mid-day heat by the action of a dinner fan, to which the water may give a mechanical motion that can be governed at will.

The graſs plat in the ſquare can be eaſily irrigated from the ſame reſource; and, by paſſing a pipe round the top rail of the iron incloſure (at an additional expence) the bordering ſhrubbery can be regularly watered with little trouble; while the Spaniſh method of applying the perforated tube may be alſo adopted to lay the duſt of the ſurrounding pavement. In ſhort, there can be no doubt that many ineſtimable benefits may be derived from ſuch a ſyſtem: the difficulty, perhaps, is to find a popular mode of adopting meaſures of public benefit, which ſhall obviate the oppoſition of party intereſts, and the inertneſs of an enterprize which is left to the office of every body and nobody. If ſomebody would but ſtep forward and be active, there ſeems to be no great doubt that the field itſelf may be rendered intereſting to all; and that when once the reſult is demonſtrated by the experience of the ſcite which I have choſen, for ſake of a central example, this ſyſtem of houſehold economy, which Bedford Square ſhall

have then adopted, will emanate from thence into all the ſquares and ſtreets of the metropolis, and render its influence a common bleſſing, by diffuſing its general ſpirit throughout the ſeveral water-works of this populous city.

Of watering and waſhing Roads.

The following accounts of watering and waſhing roads are publiſhed lately in the ſecond Volume of Communications to the Board of Agriculture, by Mr. Wright of Chelſea, and Mr. Ellis. Mr. Wright ſays, "The roads that are watered in the neighbourhood of London by truſtees *, do not extend more than three miles, excepting the Brentford truſt, which extends to Smallbury Green, near Hounſlow.

"The watering roads is a complicated buſineſs, ſome being done by an additional toll from Lady-day till Michaelmas; others by an aſſeſſment on the inhabitants. No turnpike truſt waters except it is ſpecially expreſſed in the act of Parliament. The truſtees of Kenſington and Brentford have their roads done by hire; they have pumps fixed, which is attended with conſiderable

* Many roads in the vicinage of London are watered at the expence of the inhabitants.

expence,

expence, and water carts of their own. The horſes and men work by the day; and at the neareſt calculation I can make, it coſts 6s. 6d. per mile, every day they water, for the men and horſes. The truſtees of Iſlington keep teams of their own, which are conſtantly employed in leading gravel or watering the roads; and they find this mode cheaper and more convenient. Thoſe roads that are watered by an aſſeſſment on the inhabitants are moſtly done by contract. I am of opinion, that the mode of watering roads might be improved; the method now followed muſt in ſome degree injure them. The carts are drawn by one horſe, which has not ſtrength ſufficient to pull ſo weighty a machine, laden with water, but is obliged to reſt two or three times before the cart is empty; which cauſes torrents of water to reſt on thoſe parts of the roads, and occaſions the holes and chaſms that may be ſeen in all roads that are watered. The water carts, in my opinion, ſhould be drawn by two horſes to go a regular pace, that the roads might have an equal quantity of water; the trough or cullender at the tail of the cart is too far from the ground, and the conſequence is, the water comes with too much force on the roads,

roads, which is in part the cauſe of thoſe holes before mentioned. I am of opinion that a cullender might be contrived at the bottom of the cart, and nearer the ground, which would water the roads more regularly, and might be ſtopped entirely when neceſſary. I differ in opinion with many reſpecting watering roads, and think it advantageous, provided the roads be kept clean. When roads are moiſtened by a ſhower of rain, or a water cart, the perpetual preſſure of the broad-wheeled waggons muſt bind and firm them; and the narrow-wheeled carriages at that ſeaſon of the year do not remain on the ground a ſufficient time to injure them. If the roads were well cleaned in the ſpring, and the dirt and duſt carted off, a ſmall quantity of water would make them pleaſant, without injuring them; but according to the preſent practice, the duſt or mud is raked in heaps on the ſides of the roads; there it lies to be conſumed and blown about, which annoys both travellers and thoſe who live in the neighbourhood.

The watering of roads is ſo incidental an undertaking, that no judgment can be formed of the expence, but by the mile. If the repairing of roads were farmed, the water-

ing would require but a ſmall expence, compared to what it coſts truſtees. A contractor would have the benefit of all the accidental ſhowers which happen at this ſeaſon, and no time would be loſt, as his men and teams would be ready for any other kind of employ, when not wanted on the roads. Truſtees moſtly pay for the whole day, if the teams only work a few hours. I can only add, that the principal cauſe of ſo much dirt and duſt is occaſioned, not by watering, but by laying on too large a quantity of gravel at an improper ſeaſon of the year, namely, the ſummer, which does not bind, and is ſoon ground down to duſt.

"It might not be improper to have an experiment tried in Hyde Park, where there is abundance of water to be had, and where laying the duſt would contribute ſo much to the health of the individuals of the metropolis. Let proper carts be conſtructed, with a cullender at the bottom of the cart, ſo that the water could not come out with ſuch force, and it might be ſtopped at once, when they turn, or when the watering is not neceſſary. Let there be two horſes inſtead of one, as it is too heavy a load for one horſe when the cart is at all full; and let them water

water twice a day, at four in the morning, and at eleven, when the weather requires it; and it will ſoon be found, that a ſmall quantity will not injure them; on the contrary, will bind the gravel, if it has been laid on in autumn."

Mr. Ellis has added the following remarks: "Roads upon which traffic is conſiderable, and the materials for mending not of the hardeſt quality, are apt to be extremely duſty in ſummer, and loaded with mud in winter. The uſual method of cleaning them has been by ſcraping; but to this mode there is a material objection, that much gravel is carted away, as it is not eaſy to ſeparate the ſtones which are ground down from thoſe which are only broken. The expence of thus cleaning is alſo conſiderable. Theſe evils occaſion another, that of waſhing away the mud; this has been found cheaper, more effectual, and takes off only the particles ground too ſmall to be uſeful. But it can be applied only in certain ſituations: there muſt be a declivity to prevent the water ſtagnating; it ſhould run freely, but not with too great rapidity. Where brooks and ſtreams cannot be turned in, which is often the caſe, reſervoirs by the ſide of

of the road anſwer the purpoſe, if prepared with attention *."

I beg leave to add to theſe remarks, that if the plan of national irrigation which I have herein ſuggeſted ſhould be adopted, I can ſee no reaſon why the department for watering turnpike roads ſhould not form a branch of the public ſyſtem; nor do I apprehend that the expence of irrigating the roads by the means of perforated pipes would ultimately reſult in other than a ſaving of public economy.

* The ſubjoined note is added to this paper by the Board of Agriculture:

"Theſe hints are preſented, that the Board may ſhew their attention has been given to every circumſtance concerning the roads of the kingdom, relative to which any communications have been made to them. It would be extremely deſirable, to have more complete information on the ſubject of watering and waſhing roads, from ſome of their intelligent correſpondents, who have paid particular attention to thoſe ſubjects.

Circular

Circular Letter from the Board of Agriculture on the Subject of Irrigation; together with Remarks thereon, extracted from a Letter written to the Board on that Subject by an intelligent Engineer.

Howſoever extraordinary it may appear, that a man ſeeking knowledge on the ſubject of irrigation, and leaving no ſtone unturned which might promiſe to afford it, (as I truſt the numerous authorities cited will teſtify) ſhould have omitted till the laſt that which many would ſuppoſe policy alone would have dictated for the foundation of his work; yet it is certainly not leſs extraordinary than true, that notwithſtanding I have had repeated interviews with Sir John Sinclair himſelf, and ſeveral others of the moſt reſpectable inveſtigators on this topic, and to whoſe liberal references and communications I am very greatly indebted, yet I have never been able to ſtumble on the following papers till my book was completed

up to the page where I now inſert them. This will appear poſſibly ſtill more ſtrange, and may perhaps be aſcribed to the modeſt taciturnity of that indefatigable friend to agriculture, when it is known that he had paid a very early attention to the ſubject, and that he did not omit to notice it in the third article of the ſummary concluſion of his papers concerning the origin of the Board of Agriculture, in the following words *:

"Another ſeparate head of inquiry, and ſource of incredible wealth, is, the riches to be derived from the ſtreams, rivers, canals, and inland navigations, coaſts, and fiſheries of the kingdom. That many additional millions per annum might be obtained by a proper attention to thoſe unbounded ſources of national riches, can hardly be queſtioned. By extending inland navigation, by improving the harbours on our coaſts, and by carrying our fiſheries to the height of which they are capable, it is impoſſible to ſay what additional treaſures might not be accumulated. That, however, muſt

* Communications to the Board of Agriculture, Vol. I. p. lxxviii.

entirely

entirely depend on our making the neceſſary inquiries, and following up a regular ſyſtem of improvement."

Thinking it neceſſary to call the attention of the community to the advantages of applying waſte water from the canals to the purpoſes of irrigation, he has alſo ſubjoined the following circular letter, with remarks made in anſwer to it by an experienced engineer.

Circular Letter to the Canal Companies.

" I am requeſted by the Board of Agriculture to ſubmit to your conſideration a ſubject of conſiderable national importance, *that of applying navigable canals to the purpoſe of irrigating or watering land.* We have every reaſon to believe, that the canals already formed, or now forming, might be made applicable to this very material uſe, without any injury to their common deſtination; for though it might not be proper in many caſes to ſpare water in ſum-

mer, yet in winter and ſpring, when moſt abundant, and leaſt eſſential to navigation, its utility, if thrown on the adjacent lands, would be indiſputable; and by this means a conſiderable revenue might accrue to the owners of canals, by granting certain quantities of water, weekly or monthly, to the proprietors of the adjacent ground, and infinitely to the advantage of the public.

"Should this idea meet with your approbation, the Board would apply for a general act of Parliament, to permit the proprietors of canals to make this uſe of their waſte water, and for any other general regulations reſpecting canals which may be thought neceſſary, and which you might have the goodneſs to ſuggeſt. The act might paſs ſo early, that it might be in your power, in the courſe of the enſuing winter, to try experiments on the practicability of the meaſure. Engineers, ſkilled both in navigation and irrigation, would ſoon aſcertain what quantity of water could be ſpared from each canal, at the different ſeaſons of the year, and the extent of land over which it might be conveyed. It may not be improper to inform you, that this uſe of navigable canals has long

long been common, and carried to a conſiderable extent in the Milaneſe, where the rents paid for water thus taken have in ſome caſes equalled the expence of forming the navigation; that this plan has rendered that part of Italy among the moſt fertile and opulent in Europe, and contributed more to the improvement of the country than any other idea that has been adopted. It is from the water meadows thus obtained that the celebrated Parmeſan cheeſe is in many inſtances produced.

"The anxiety felt by the Board of Agriculture for extending the benefits reſulting from your uſeful undertakings to new objects, which might prove equally beneficial to yourſelves and to the public, has occaſioned this trouble on the part of,

"GENTLEMEN, &c."

Extract of a Letter from an intelligent Engineer on the foregoing Subject.

" I have received your circular letter reſpecting the plan of watering of land by the means of navigable canals; on which there ought only to be one opinion as to its being a point of the greateſt importance, which could have come under the conſideration or patronage of the Board of Agriculture; and if any obſtacles ſhould occur, they muſt ariſe from prejudices which time will wear off; for that ſuch a rational application of the waſte water of canals will at one period or another take place, ſeems not to admit of a doubt.

" In Europe, the improvements of the Milaneſe are a ſtriking inſtance of the fertility which may be created by ſuch an application of the waſte water of canals; and if any thing elſe was wanting to add to this conviction, the economy of the waters of the Nile may be produced as another inſtance, and perhaps even a more ſtriking one than the Milaneſe; as in this laſt

laſt caſe, an unrivalled fertility was ſpread over the ſandy waſtes of Egypt and the Thebais, and even over the ſcorching plains of Lybia.

"The lake Mœris, formed as a reſervoir in the boſom of barren mountains, is a feature which cannot be miſtaken; and it ought to prove a uſeful leſſon for the management of rivers in general, moſt of which, in ſome place or other, may be treated in the ſame way: the exceſs of floods may be drawn off, and in dry ſeaſons water may be iſſued for the uſe of navigations of the ſame rivers, for the working of mills, for the purpoſes of watering land, and for ſupplying navigable canals.

"The very lakes which now exiſt in Great Britain may in general, and at a very moderate expence, be raiſed a few feet above, or drawn off a few feet below, their uſual level; and this, upon extenſive ſurfaces, would ſupply a quantity of water which would produce much fertility to the countries which lie below that level.

A general ſurvey of the kingdom, directed ſo as to aſcertain the comparative levels of its ſurface, would be a very neceſſary ſtep towards

towards the general management of water; and this ſurvey ſhould be made with great accuracy, and noting the leading objects and peculiar advantages and diſadvantages in each diſtrict, with their relative ſituations as to the connecting diſtricts; and from theſe ſeparate reports and ſurveys a general arrangement of the whole might take place, and many uſeful plans be pointed out.

"In general, I ſhould ſuſpect that in this buſineſs there are evils to be guarded againſt, and which are likely to ariſe from two very oppoſite claſſes of people. In the one claſs may perhaps be ranged thoſe land-owners and mill-owners, whoſe minds are not ſufficiently enlightened as to be ſenſible of the general utility of the ſcheme, or the benefits which muſt eventually ariſe to themſelves; and they, of courſe, will be averſe to ſubmitting to any alterations which may interfere with the water.

"And the other claſs will conſiſt of projectors and projecting engineers, who may be in any ſhape engaged in the arranging or executing this plan, and who being wholly engroſſed with new ſchemes, may be led to depiſe real obſtacles, and give a favourable complexion to impracticable projects.

As

As the firſt, it is hoped, will not form a majority of the community, an act of Parliament will remove all legal obſtructions as far as it reſpects them; and a perſeverance in repeating calm demonſtrations, and the ſenſible operation of the ſcheme itſelf, muſt in the end convince them, that ſo far from this plan proving an injury or injuſtice, that not only the country at large demands it, but that they will be benefited individually; indeed, there is no reaſon but their own obſtinacy, why they ſhould not be benefited immediately, and that in a double capacity; becauſe, as canal ſtock is transferable and fluctuating, theſe land-owners and mill-owners may become proprietors of the canal navigations, and ſo receive a ſhare of the advantages ariſing from this diſtribution of water, and they may likewiſe, in this way, have a voice in the direction of its operations.

"And beſides this, canal ſtock ſeems more than any other property to connect the apparent intereſts of the greateſt number of individuals, with the improvement of the land and manufactures of the counties through which the canals paſs, ſince it is in proportion to this proſperity that the canal proprietors can receive their pecuniary ad-

vantages from an increaſed tonnage: thus a number of perſons reſiding in diſtant quarters of the kingdom, who probably could never have become land-owners, are in this way intimately connected with the improvement of the land, &c. This is the circumſtance that I take the liberty of mentioning more at length, becauſe I do not recollect that it has hitherto been taken notice of; and it appears to me of conſiderable importance. I have for inſtance obſerved, that in a certain inland canal navigation, where there are upwards of 1200 proprietors, moſt of them people in tolerable circumſtances, and in trade, and reſiding in twelve counties; that all of them are looking with anxiety to the increaſing produce and conſumption of Cheſhire, Derbyſhire, Montgomeryſhire, and Shropſhire, although, if it had not been for this circumſtance, very few of them would have known or have concerned themſelves about that part of the country.

" With regard to the being led aſtray by projectors, or projecting engineers, this may be in a great meaſure prevented by the choice in the appointment of the engineers who are to take the ſurveys, and the Committee under which they ſhall act, and the care to

be

be taken in the comparing and arranging the ſeveral reports and ſurveys, and many of the Members of the Board of Agriculture will, from their own local knowledge, be enabled to check any falſe repreſentation."

Before I diſmiſs this ſubject, I feel it a duty which I owe to inventive talent, and to the unpatronized engineer, of ſelf-taught abilities, to take ſome notice of a hackneyed habit which many profeſſional men have adopted in reſpect to the proſperity of Genius; who they affect rather to conſider and treat as the enemy of the arts, than the parent of human improvement, and of all the old beaten-track knowledge which tuition and time has been able to beat into that invariable ſyſtem, the ultimatum of their capacity. One would ſuppoſe, alſo, from the extreme care which ſome are wont to take in their cautions concerning the public intereſts (permit me to ſay a little out of their path in trade) that they either conſidered the Board of Agriculture and Parliament as a parcel of political ſchoolboys ſent to London for their inſtruction; or that they were diſtruſtful of their own ſtrength: had forgot that projection is the ſcience which alone can complete a maſterſhip in their moſt ho-

nourable profeſſion, and give them bread; or perhaps their good luck in being heretofore employed by men who were either too proud, too weak, or too diſſipated to look into their own affairs, had induced them to view the Board of Agriculture as cattle of this deſcription. I can only ſay, that on a review of the premiſes, (let what will have been the motive) common reaſon would ſeem to revolt at its dictatorial impudence, and its grovelling illiberality. The mighty work which eſtabliſhed this grand national inſtitution, (from which all the world have derived extraordinary light and benefit) has nothing ſelfiſh: yet Sir John Sinclair, whoſe unparalleled zeal will record him among the benefactors of man, to the lateſt period of time was a *Projector*.

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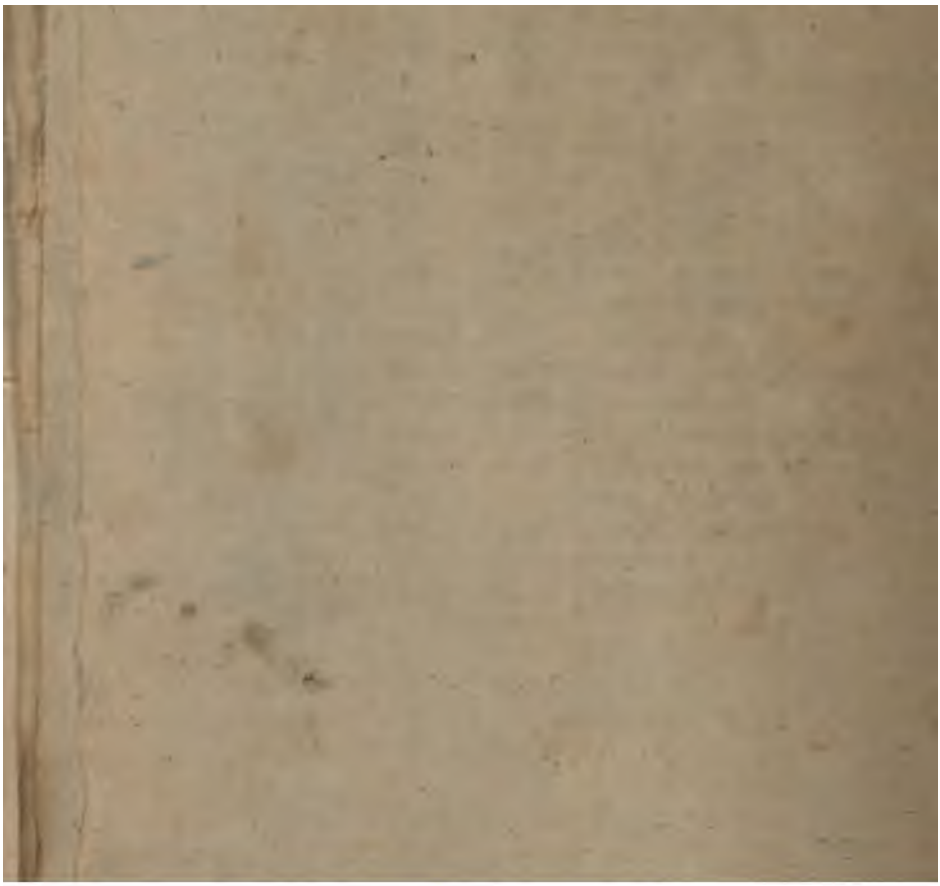
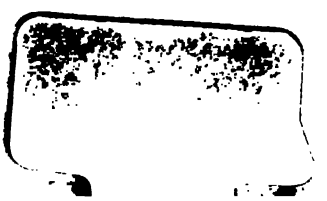
ERRATA.

ERRATA.

Page	8,	line 5,	for works, read works *of*
	38,	8,	for Morravian, read Moravian
	55,	13,	for waters, read *water*
	75,	4,	for irrigation, read *irrigator*
	110,	1,	for to lamented, read to *be* lamented
	118,	10,	for recommends, read *adviſes*
	129,	4,	for culvers, read *culverts*
	137,	3,	for dying, read *drying*
	155,	16,	for their, read *the*
	187,	1,	for land, read *ſand*
	198,	23, 24,	for that all elevated countries which, read, that *the people of* all elevated countries *who*
	205,	3,	for as Shadwell, read as *the* Shadwell
	211,	18,	for let sat, reads *lets at*
	220,	1,	(in the note) for Farmers, read *Fenna's*
	260,	10,	for Weſtdale, read *Waſtdale*
	262,	14,	for portage, read *partage*
	352,	4,	for Lumbeſton, read *Lumberton*
	365,	4,	for nd, read *and*
	367,	27,	for characters, read *character*

THE END.

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